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ESSENTIAL RENAL HAEMATURIA

A STUDY OF SEVEN CASES

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THE term essential renal haematuria refers to that group of cases in which there is definite and often severe and recurrent unilateral renal bleeding in the absence of demonstrable morphological changes in the renal tract.

The following observations are based on the study and results of 7 such cases occurring over the past five years where nephrectomy has been carried out and the kidney has been subsequently examined.

The aim of this paper is to present the findings in this small group of cases and to indicate another cause of "essential" haematuria.

Historical Survey

Over one hundred years ago Rayer in his *Traité des Maladies des Reins*, 1837, described the concept of bleeding from a healthy kidney. This however was not an original concept and idiopathic haematuria was recognized and described before Rayer's papers.

With the assistance of microscopic pathology the idea of idiopathic renal haematuria lost favour and it was generally felt that there must be an organic change in the kidney to account for the haematuria. However, in spite of this general opinion widely held in the latter part of the 19th century, there remained a group such as Socoloff, Sebatier, Legueu, Broca, Klempererer and others who wrote papers maintaining the concept of idiopathic haematuria.

Klempererer (1897), for example, postulated that the bleeding from a healthy kidney in essential haematuria was due to a disturbance of the vasomotor system of the renal blood vessels which resulted in a dilatation of the blood vessels especially those of the renal pelvis and from these dilated vessels there was a diapedesis of red blood cells into the renal pelvis.

These writers had a definite influence on medical thought particularly as many clinicians then, as today, had patients with apparent haematuria for which no demonstrable cause could be found.

Thus the concept of essential renal haematuria has always had adherents and it is probable that until a mechanism can be demonstrated in each case of renal bleeding it will always have supporters.

However through the years the group of conditions which constitute essential haematuria is being steadily decreased.

Rovsing, Israel and Schenck were amongst the early writers who attacked the idea of the "healthy" kidney bleeding and they expressed the opinion that there is always some cause for the bleeding even though it be an undiscovered one.

Many workers since the early years of this century have demonstrated different causes for renal haematuria. Whilst calculi and renal tuberculosis which were and still are common causes of haematuria, can usually be discovered by modern investigational

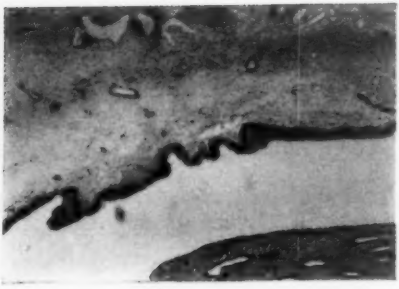
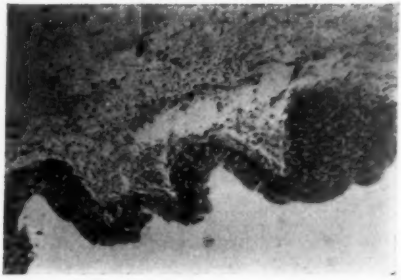


Fig. I



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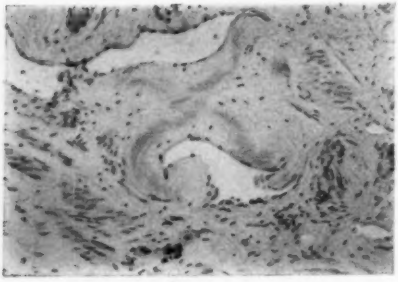

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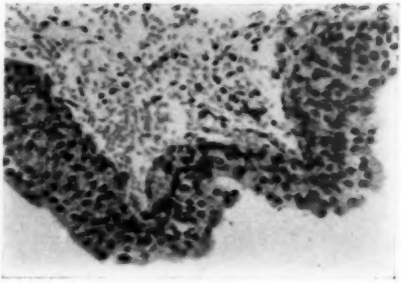

Fig. IV

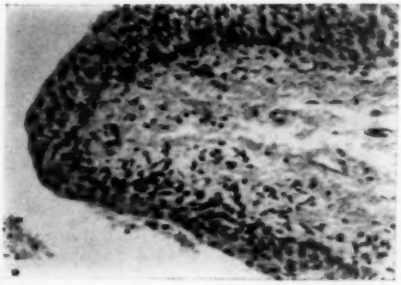

Fig. V

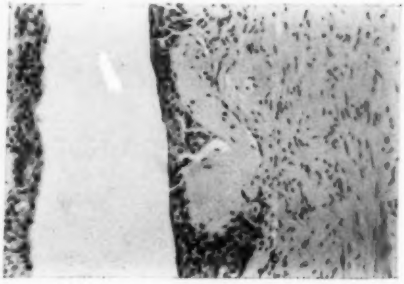

Fig. VI

FIG. I. A low power photomicrograph showing the vascularity of the subepithelial tissue of the renal pelvis and small areas of haemorrhage beneath the epithelium.

FIG. II. A high power photomicrograph of portion of the field of Fig. I showing a dilated subepithelial capillary with a break in the continuity of the vessel wall.

FIG. III. A high power photomicrograph of another portion of the field of Fig. I showing changes in perivascular connective tissue.

FIG. IV. A high power photomicrograph of a subepithelial area of haemorrhage. The red cells can be seen passing between the cells of the "intact" pelvic epithelium.

FIG. V. A further view of the red cell migration through the renal pelvic epithelium.

FIG. VI. This photomicrograph from a different field shows areas of healing in "old" subepithelial haemorrhage.

methods, the tiny neoplasm causing no distortion of the kidney or other radiological alteration remains today as one of the unexplained causes of essential haematuria.

Many other conditions have been shown as a cause of essential haematuria and a good review of the papers published up to 1928 is given by Bumpus and a study by Wilbur and Priestley (1935) adds to this.

Fenwick in 1903 and Cabot in 1909 and many writers since have described angiomatous changes in the renal papilla or of vessels of the renal pelvis. There are quite numerous recorded examples of patients with an apparent essential haematuria in which later it has been possible to demonstrate haemangiomatous or telangectatic vascular malformations occurring in the renal pelvis and in other parts of the kidney. McMahon and Latorraca described three cases of essential haematuria in which they demonstrated the existence of a direct communication between a dilated venous sinus of the pericalyceal venous plexus and the lumen of the calyx.

PRESENT STUDY

Clinical features

This series consists of 7 cases of essential renal haematuria who have had a nephrectomy, occurring in the practice of one of us (J.B.S.) over a five-year period.

The ages of the patients ranged from 25 years to 42 years. Of the seven patients there were 4 males and 3 females.

All the patients had one feature in common, namely the sudden onset of painless haematuria, noticed accidentally and occurring in the absence of any other general or urinary symptoms. General examination and blood pressure estimations did not show any other abnormality. The urine showed large numbers of red cells, but pus cells, casts or albumen were not found. Bacteriological investigation including cultures for tubercle bacilli although carried out on several occasions, remained negative. Cystoscopy was performed on not less than three occasions in each case and the bleeding was always found to be coming from the one side. All patients had both intravenous and retrograde pyelograms performed without revealing any organic lesion in the kidney. Although in two cases a suspected filling defect in the renal pelvis or calyces necessitated the repetition of pyelography, in each case the suspected filling defect had disappeared on this second examination and must be presumed to have been due to blood clot. One patient later did suffer pain with haematuria and the passage of clots and so presumably this pain could be regarded as a true clot colic.

The bleeding had been in progress for one week at the shortest interval and six weeks at the longest before investigations were begun. In three cases the blood loss was sufficient to necessitate blood transfusion before operative treatment could be undertaken.

These seven cases subjected to nephrectomy were operated on for two reasons.

1. In the first group nephrectomy was performed because of severe and continuous bleeding without intermission for a period in excess of four weeks.
2. In the other group of four cases, where the bleeding had been intermittent, nephrectomy was carried out because of the fear of missing a tiny carcinoma of the kidney.

This fear is a real one because in the clinical experience of one of us (J.B.S.) on two patients outside this series where a kidney was removed for haematuria, the pathologist's examination showed a very small and prevously quite unexpected carcinoma of the kidney. Both of these patients died within a short period (less than eight months) with multiple secondaries. Thus it is felt that the risk of missing such a carcinoma must be a factor in deciding the course of treatment for these patients.

PATHOLOGICAL FEATURES

The gross appearance of the kidneys examined in this series has been normal as regards size and external appearance. The capsule has stripped easily and the surface of the kidney has been smooth and normal in appearance. On sagittal section the cortical and medullary portions of the kidneys have been of normal appearance but in the renal pelvis macroscopic changes have been present. In some cases these changes have been small, appearing as petechial areas of haemorrhage occurring in the pelvic mucous

membrane. In other cases the changes have been more obvious and the calyces have contained blood clot and the lining of the calyces has shown larger purpuric patches which appeared to be beneath the actual mucous membrane. In our experience these changes have generally been confined to one or two calyces and the pelvic lining of the adjacent renal papillae. No vascular malformations nor other macroscopic abnormality of the vessels including the large vessels of the stump has been observed in this series.

Microscopic appearances

The cortex and medulla of the kidney appear normal although there is possibly some increased vascularity of the papillary portion of the medulla. However, in the sub-epithelial tissue of the pelvis and calyces the microscopical structure of the macroscopic changes is of interest. The sub-epithelial pelvic tissue consists of a loose connective tissue containing smooth muscle fibres, nerve fibres, blood vessels and lymphatics; and in this tissue there are areas of haemorrhage. In some cases these areas of haemorrhage could be seen in the slide without the aid of a microscope; in others they are found as numerous small foci of haemorrhage lying immediately beneath the epithelium or just adjacent to it.

In addition there is a general dilatation of the small capillaries and arterioles, so that the appearance is one of increased vascularity (Fig. I). The areas of haemorrhage can often be found to be in close association with a dilated capillary, and it seems that the haemorrhage has occurred from a point in the capillary wall which has undergone a degenerative change, and shows alteration of staining affinity with a break in the continuity of the vessel wall (Fig. II). The perivascular connective tissue in other areas also shows a staining difference suggesting some degenerative change, and this is illustrated in Fig. III. An observation of some importance is shown in Figs. IV and V.

These photomicrographs show small areas of haemorrhage lying beneath the epithelium and the red cells from the area of haemorrhage can be seen lying between the cells of the pelvic epithelium suggesting a direct migration through the intercellular spaces of the pelvic epithelium. This observation is one which could be compared with diapedesis postulated by Klempererer and referred to above. Finally it seems probable that these areas of haemorrhage undergo a process of healing and in Fig. VI small hyaline eosinophilic staining areas lying just beneath the epithelium are present and in some of these partly healed areas the remains of red blood cells are present.

In summary the microscopic observations are:

1. Dilatation of the small vessels of the renal pelvic submucosa.
2. Degenerative changes in the vessel walls with adjacent areas of haemorrhage in the loose sub-epithelial connective tissue.
3. The passage of red cells directly through the pelvic epithelium without apparent break in this epithelium.
4. There is evidence to suggest that a process of "healing" occurs.

DISCUSSION

The cause of the changes listed above is a matter for conjecture and further study. The nature of the change suggests that it is the result of some unidentified inflammatory agent. Such an unknown agent appears to cause dilatation of the vessels, degenerative changes in the vessel walls, and possibly it causes a loosening of the intercellular substance of the connective tissue and an increased permeability of the renal pelvic epithelium. It may seem that the loss of blood through the epithelium in such a manner could not be great but attention is drawn to the fact that in three of these patients preoperative transfusions were required and one case required 2,500 ml. of blood.

CLINICAL MANAGEMENT

The clinical management of essential haematuria remains a difficult decision.

The findings of this small series are possibly a further reason in favour of conservatism in that there is evidence that the change described may undergo healing.

However in spite of this suggestion there will be occasions when nephrectomy must be undertaken because of excessive and persistent blood loss.

Further the diagnosis of the type of change described in this paper cannot be made until nephrectomy has been undertaken and the fear of the minute bleeding neoplasm cannot be excluded until the kidney has been removed.

These investigations have been confined to patients who have shown unilateral renal haematuria. It seems not unlikely that the type of condition described may affect both kidneys either at the same time when nephrectomy is never considered or if at a different time when a previous nephrectomy may be a cause for regret.

It has been suggested that the changes are the result of some ill-defined inflammatory stimulus. It may be that the condition is a localized collagen disorder and it is intended to use steroid therapy in certain cases in the future.

SUMMARY

1. A brief review of the history of essential haematuria has been made.
2. The clinical and pathological findings in a series of seven cases of essential haematuria submitted to nephrectomy is given.
3. It is suggested that management should tend towards conservatism, with repeated and prolonged follow-up investigation. However one cannot give an absolute assurance that a malignant neoplasm is not present, and it is surprising in this small series how much pressure was brought to bear by patients and relatives in favour of nephrectomy, for this reason.

ACKNOWLEDGEMENTS

The colour photomicrographs were kindly prepared by the Pathology Department of the University of Melbourne.

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OESOPHAGEAL ATRESIA

CONSTRUCTION OF A NEW OESOPHAGUS

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IN 1929 Vogt, an American radiologist, divided cases of oesophageal atresia into three main categories as follows (see Fig. I):

Type I Complete absence of oesophagus.

Type II Atresia without tracheo-oesophageal fistula, upper and lower segments both ending blindly.

Type III Atresia associated with tracheo-oesophageal fistula.

(a) Upper segment entering trachea, lower segment blind.

(b) Upper segment blind, lower segment entering trachea.

(c) Both segments entering trachea.

Fig. Ia is the diagrammatic representation of the types of the deformity as tabulated by Vogt, whilst Fig. Ib is an actual photograph of the common deformity, Type III (b).

Ninety per cent. of cases are of Type III (b).

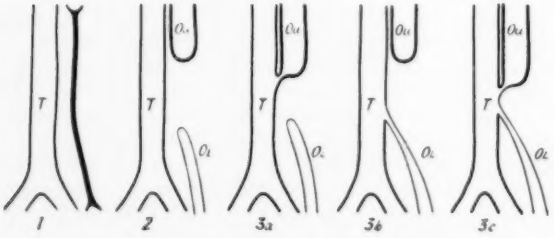

FIG Ia. Vogt's classification of oesophageal atresia.
(T — trachea; Ou — upper oesophageal segment; Ol — lower oesophageal segment.)

Haight and Towsley (1943) reported the first successful direct oesophageal anastomosis, performed in 1941, in a case of oesophageal atresia Vogt Type III (b). Subsequently Haight (1944) described the management in greater detail, following which the treatment of this type has become, to a considerable extent, standardized along the lines which he laid down.

The management of cases in which the oesophageal deficiency is so great as to render impossible a direct anastomosis between the two segments is still, however, the subject of debate. This is a composite group, comprising practically all cases of Vogt Type II (atresia without tracheo-oesophageal fistula) and a small percentage of cases of Vogt Type III. A third component may perhaps be suggested — cases whose general condition is so poor as to contra-indicate the performance of oesophageal anastomosis.

Fig. Ib. Oesophageal atresia, Vogt Type III (b).

Cases of Vogt Type II will be diagnosed by routine X-ray investigation (see Fig. II), whilst those of Vogt Type III who qualify for the group now under discussion will be determined either at operation (where there is a long gap between the segments) or by clinical evaluation.

The following is the history of an infant in whom the construction of a new oesophagus proved essential.

FIG. II. X-ray, Vogt Type II (upper segment outlined with lipiodol).

S.H., a male baby, was born on 20th June, 1958, weighing 5lb. 8oz. The infant was noticed to be "mucousy" from the time of birth and had several spontaneous attacks of cyanosis and coughing. A tube passed down the oesophagus was arrested at a distance of 12 cm. from the gum margin, thus establishing the diagnosis of oesophageal atresia. X-ray examination showed air to be present in the stomach and the blind upper segment of the oesophagus was seen delineated with lipiodol. The anatomy was thus that of the common Vogt Type III (b) (see Fig. III).

He was admitted to Brisbane Children's Hospital on 21st June, 1958, where, thirty-six hours after birth, a right thoracotomy was performed by Mr. Morgan Windsor. The lower oesophageal segment was found to enter the trachea posteriorly at the bifurcation; the upper segment had its blind fundus situated at the level of the neck of the first rib. After detachment of the lower segment from the trachea and mobilization of both segments it was found that their approximation was impossible. Accordingly, a cervical oesophagostomy was performed on the right side of the neck, medial to the sternomastoid muscle.

On 23rd June a Janeway gastrostomy was performed and feeding practised successfully by this route so that, by 6th April, 1959, the infant's weight had reached 15lb. 13oz. On that date he was admitted to the Royal Children's Hospital, Melbourne.

On 29th April, 1959, the first stage in the construction of a new oesophagus was undertaken.

FIG. III. X-ray of S.H. — Vogt Type III (b).

The abdomen was opened by a transverse upper abdominal incision and the vascular arrangement of the transverse colon examined. The middle colic and ascending branch of the right colic arteries were temporarily occluded by bulldog clips and it was seen that the whole of the transverse colon could be adequately supplied with blood from the left colic artery via the marginal artery. The middle colic and ascending right colic vessels were then divided between ligatures. The colon was sectioned at the hepatic flexure and at a point just distal to the splenic flexure so that, after division of the gastrocolic omentum and transverse mesocolon, the transverse colon was left as an isolated loop nourished by the left colic and marginal arteries.

The continuity of the rest of the colon was reestablished by anastomosis of its cut ends (using two layers of interrupted 4/0 silk sutures (see Figs. IV and V).

The proximal end of the transverse colon loop was closed and attached to the right end of the abdominal incision, whilst the distal end was brought

to the surface as a temporary colostomy at the left extremity of the incision. Routine closure of the abdominal wall completed this stage.

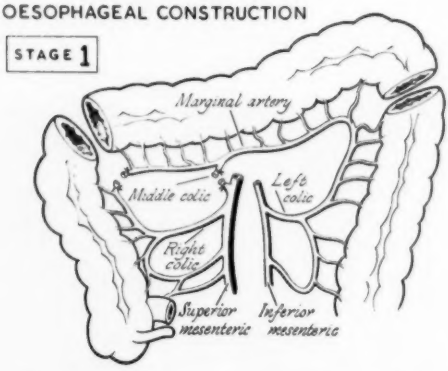

FIG. IV. Preparation of transverse colon for transplant — Stage 1 of oesophageal construction.

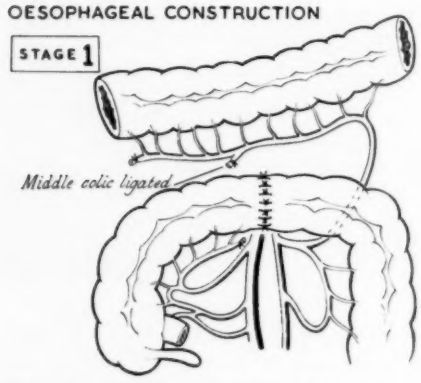

FIG. V. Reconstitution of remaining colon — Stage 1 of oesophageal construction.

On 6th May, 1959, the second stage was performed. The initial abdominal incision was continued onto the left thoracic wall and the 9th rib resected throughout most of its extent. The diaphragm was incised from costal margin to a point about one inch from the oesophageal hiatus. The spleen was removed. The transverse colon loop was freed and that part which had formed the colostomy was excised. The lower oesophageal segment in the mediastinum was isolated and found to be of practically normal calibre in its distal two inches.

It was transected ¾" above the diaphragm and the proximal portion discarded. The colonic loop was readily brought up through the diaphragmatic incision and found to be of sufficient length to extend well up into the neck. It was able to be placed comfortably along the posterior mediastinum without tension on the left colic artery which formed its vascular pedicle. The distal end of the colonic loop was anastomosed with the cut end of the thoracic oesophagus (using two layers of interrupted 4/0 silk sutures). The proximal end was passed behind the clavicle, brought forward between the two heads of the left sternomastoid muscle and sutured to the edges of a skin incision made at this point. In its thoracic course the loop was anchored to the posterior mediastinum by a series of silk sutures. The incision in the diaphragm was sutured and closed snugly (but not too snugly) around the left colic vessels (see Fig. VI). Finally, the abdomen and thorax were closed, the latter with under-water drainage.

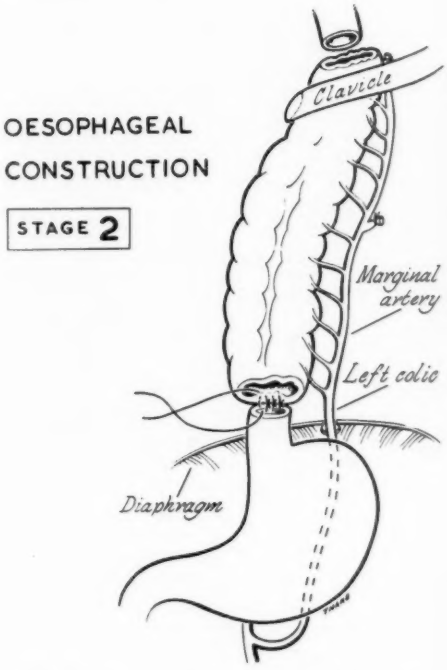

FIG. VI. Transverse colon transplanted into left pleural cavity — Stage 2 of oesophageal construction.

On 26th May, 1959, the third stage was effected.

A transverse incision was made which encircled the cervical oesophagostomy on the right side and the cervical colostomy on the left (see Fig. VII). Oesophagus and colon were freed from their superficial attachments and that part of the colon which was external to the skin surface was excised. The cervical oesophagus was readily transposed to the left side of the neck, being passed behind the trachea and then forwards medial to carotid sheath. This manoeuvre brought it into apposition with the cervical end of the colon, to which it was now anastomosed using a single layer of interrupted sutures of 4/0 chromic catgut. The division of the

sternal head of the sternomastoid muscle facilitated this procedure and its subsequent reconstitution placed the new oesophageal pathway deep to the muscle. Lastly, the cervical incision was closed in a manner similar to that commonly used for thyroidectomy.

On the fourth day after operation an oesophageal fistula through the cervical wound developed. This closed spontaneously four days later.

The child was, by this time, a year old and had never been fed by mouth. The greatest difficulty was now experienced in teaching him to eat in the normal way. A barium swallow showed that the new "oesophagus" (ex-colon) filled rapidly with barium, but that emptying into the stomach was slow. No stricture was present at any point (see Fig. VIII).

FIG. VII. S.H. showing cervical oesophagostomy (on the right side) and cervical colostomy.

On 1st August, 1959, the gastrostomy was closed as, by this time, enough nourishment was able to be induced into the child by the normal feeding mechanism.

Over a period of many years a great number of techniques for oesophageal construction and replacement have been devised.

Tubes have been utilized and hollow viscera transplanted and placed extrapleurally (antethoracic or retrosternal) or intrapleurally in close relation to the posterior mediastinum. They have consisted of skin, stomach, small bowel, plastic tubes and finally large bowel.

Skin tubes have been discarded for the following reasons; they are difficult to construct, difficult to anastomose to stomach and oesophagus and liable to ulceration, stricture and fistula formation.

The stomach can be elevated and anastomosed with the proximal oesophageal segment but gastric reflux is free, liable to cause oesophageal ulceration and at times to overflow into the respiratory passages. Furthermore a thoracic stomach is not compatible with requisite thriving of the infant.

Jejunal transplants have been extensively utilized but their blood supply is well recognized to be precarious and this is especially so in infants. Other things being equal, a less delicate vascular pedicle is required.

FIG. VIII. X-ray showing barium passing into stomach from the new oesophagus.

Each technique has its own inherent defects but there is one additional defect common to all procedures which anastomose the substitute oesophagus directly to the stomach — that of peptic ulceration and stricture formation in the transplant.

Cases of oesophageal atresia always possess a distal segment of oesophagus to which the transplant can be anastomosed. Gastric reflux is then prevented by the mechanism which is normally responsible for continence at the gastro-oesophageal junction.

When it is found necessary to interpolate a transplant tube in order to complete construction of the oesophagus, one feels that it

should be a cardinal principle that the distal point of union of the transplant should be with the oesophagus in the chest. If this view is accepted it automatically condemns those procedures in which the new oesophagus is placed antethoracically or in the retrosternal extrapleural position.

The colon, probably, conforms best to the criteria necessary in a viscus which is to substitute for the oesophagus. Sections of it can reasonably readily be transposed into the chest on the vascular pedicle of one or other of the colic vessels. This pedicle will adequately nourish a length of colon sufficient to reach to the cervical element of the oesophagus. The colon anastomoses well with the oesophagus and conducts food in a comparatively satisfactory way.

The case reported here is an example of the application of the principles formulated by Waterston in 1954 and described in more detail by him and Sherman in 1957. Although still very early in its post-operative course, it can be considered as a further indication that the procedure is essentially feasible and may be, perhaps, the best present solution to the problem of the construction of a composite oesophagus.

It should, nevertheless, be realized that the best oesophagus a patient can have is the organ which was developed for that purpose. Every endeavour should be made to use this, and only this, in the construction of the ultimate oesophageal tube. If adequate length is not present, it will be necessary to tread the thorny pathway to which this article is a signpost — and a warning.

SUMMARY

1. Indications are formulated for the use of a visceral transplant in the oesophageal construction necessary in cases of oesophageal atresia.
2. It is suggested that colon is the viscus most suitable for this purpose and that it should be placed intrapleurally along the posterior mediastinum.
3. A case of oesophageal atresia is reported in which a new oesophagus was built using transverse colon as such a transplant.

ACKNOWLEDGEMENTS

My thanks are due to Mr. Morgan Windsor to whose early surgery and management the case reported in this paper owes his survival, to Mr. D'Arcy Sutherland for the much appreciated gift of the colour slide from which Fig. Ib was prepared, and to Mr. C. Murphy and the Photographic Department of the Royal Children's Hospital for their help in connection with the illustrations.

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INTRACRANIAL HAEMORRHAGE IN DISORDERS OF BLOOD COAGULATION

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Introduction

THE natural arrest of bleeding is a most intricate biological achievement. It involves at least two processes:

(i) the reaction of the injured vessels, and

(ii) the coagulation of the blood.

The first is an immediate haemostatic response, effective but transient. The second, the formation of a coagulum, is delayed, but gives a sustained occlusion of the injured vessels, long after their initial reactive constriction has been relaxed. Both processes are vitally important, and both can be defective. Inefficiency in the vascular response, as a pure defect, is rare, though several forms (some hereditable) are known. Disorders of coagulation on the other hand are quite common, and have received much attention in recent years.

It is well known that these coagulation disorders are often complicated by intracranial haemorrhage, either spontaneous or after trauma. The subject has been reviewed by Chalgren (1953) and it presents many features of practical interest. In some cases of this type, diagnosis will be easy and treatment no problem, because impossible: but in others there may be both doubt and opportunity. There are occasions when the recognition of the clotting defect and the evaluation of its clinical significance may be extremely difficult. More important, there are cases where the possibility of successful neurosurgical intervention seems offered and in these formidable practical problems will arise.

An expanding intracranial haematoma is usually an imperious surgical emergency. But even under normal conditions, neurosurgical haemostasis is tedious and uncertain. Operation with the added hazard of a defect in natural blood clotting may be followed by disastrous delayed bleeding.

Modern theories on the nature of coagulation have reached a complexity appalling to anyone not expert in this field. A recent monograph upon the subject was prefaced by a delightful but despairing quotation from Lewis Carroll (Biggs and Macfarlane, 1957). The uninitiated reader will endorse both the despair and the implication that coagulation has much in common with Alice's wonderland. It is not surprising that the recent surgical literature contains few comprehensive studies of the practical problems raised by haematologists working in this field.

Nevertheless, intracranial haemorrhages complicating major disorders of blood coagulation are not rare. In a period of three years, five examples were seen in the practice of the neurological and neurosurgical units of the Royal Adelaide Hospital. A sixth case, not fully investigated, was seen at the Adelaide Children's Hospital (Table 1). It seems worthwhile therefore to review those defects in the clotting mechanism likely to present as neurosurgical emergencies, and to consider their management in the light of modern theory and practice.

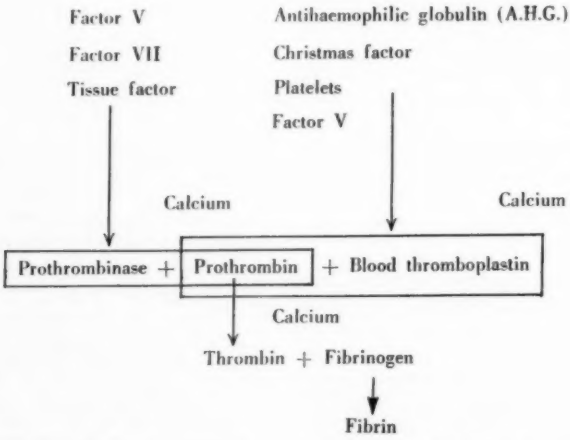
The Mechanism of Clotting

The classical theory of blood coagulation is simple and convincing. It derives from Morawitz (1905) and earlier workers and is still presented in many textbooks. The basic reaction in this concept is the conversion of fibrinogen, an element in the plasma, to fibrin, the solid component of the coagulum. This conversion is effected by the enzyme thrombin, which in turn is formed by the interaction of an inert precursor, prothrombin, and some substance liberated by tissue injury.

This palatable hypothesis is in large part verified. It has however been elaborated, to our great confusion, by many workers, using many terminologies. Other factors have been identified, or at least postulated, and finality

seems still distant. As a working schema, Biggs and Macfarlane (1957) present the diagram shown below.

This system is at present accepted, with many reservations, by most British workers, and at least provides a basis for discussion. It will be noted that two partly independent systems are postulated, both capable of initiating the conversion of prothrombin to thrombin. The first, which involves the interaction of a tissue factor with certain plasma factors, is considered less important. Chief interest therefore attaches to the second sequence leading to the production of blood thromboplastin. All the elements in this system are present in circulating blood, and coagulation diseases involving each element have been recorded: some rare, and some common.



Even this complex hypothesis over-simplifies the available data. It omits certain plasma coagulation factors of uncertain but possibly important role. It ignores the known existence of natural inhibitory or anticoagulant factors, whose presumed function is the prevention of spontaneous intravascular thrombosis. And it gives only one function to the blood platelets: it is in fact likely that the platelets take part in a number of other reactions, besides that leading to the liberation of blood thromboplastin. In particular, they are able to form platelet plugs in the mouths of damaged vessels at a very early stage in haemostasis, and this occlusive reaction can even develop without the formation of a fibrin coagulum.

TESTS OF BLEEDING AND CLOTTING FUNCTIONS

The diagnostic procedures now in common use can be considered in relation to the foregoing hypothetical mechanism of coagulation.

(i) *The whole blood clotting time.* This is measured *in vitro*, under standard conditions. Theoretically, it should give an over-all index of the efficiency of the coagulation system. In fact, it does not: a normal clotting time does not exclude a grave coagulation defect. This is because the test does not measure the reserve powers of the blood, upon which in a severe emergency successful haemostatic coagulation may depend. But, on the other hand, a prolonged clotting time is highly significant.

(ii) *The bleeding time*, measured after a small skin puncture. This is mainly a measure of the vascular response, not of the clotting mechanism. It is however of importance in the present study because certain diseases (notably thrombocytopenic purpura) involve both reactions. It is nevertheless an unreliable procedure.

(iii) *The platelet count.* This needs no elaboration.

(iv) *The capillary fragility test.* This is measured as the response to a tourniquet, applied for a fixed time (five minutes): petechial haemorrhages distally indicate a defect in vascular endothelium, as seen in

scurvy, and also in thrombocytopenic purpura. In pure coagulation diseases, it will of course be normal.

(v) *The "prothrombin time."*

(a) One-stage method (Quick). In this test, an artificial thromboplastin (tissue extract) is added to the patient's plasma, and the time at which a firm clot appears is taken as an index of the plasma prothrombin activity. This test is abnormal in the presence of a deficiency not only of prothrombin itself, but also of its precursors, notably factors V and VII. It will also be abnormal if fibrinogen is lacking. On the other hand it is no measure of the blood thromboplastin system. Nevertheless, as a practical guide, it is of great value.

(b) Two-stage method. Here the production of thrombin in a mixture of artificial thromboplastin and test plasma is measured by titrating samples from the mixture against a standard fibrinogen. There are fewer variables in this test, and it gives a better index of the prothrombin content of the blood, but the technique is more difficult. For the control of anticoagulant therapy, the one-stage test is usually considered satisfactory.

(v) *The thromboplastin generation test.* This complex but important test is the basis of modern coagulation studies, at least as far as they concern blood thromboplastin and its precursors. It is possible to prepare *in vitro* a plasma deficient in prothrombin, factor VII and the Christmas factor, by treatment with aluminium hydroxide. Such a plasma will retain antihaemophilic globulin (A.H.G.) and factor V. Defibrinated serum on the other hand will contain factor VII and the Christmas factor, but not prothrombin, A.H.G., or factor V. These two reagents will thus be complementary, and if they are incubated together, with a suspension of plasma-free platelets, a potent thromboplastin is generated. This can be assayed on thrombin-containing plasma.

All three reagents—treated plasma, serum, and platelets—can be varied, substituting either a known normal sample, or a sample of the serum under test. This permits the separate demonstration, and if necessary the quantitative assay, of defects in A.H.G., in the Christmas factor, and in the platelet thromboplastic factor (Bonnin, 1957). The quantitative assay of A.H.G. is of very great practical value in the management of haemophilia.

(vii) *Fibrinogen content* can be estimated in various ways: most simply, by precipitation with ammonium hydroxide.

TABLE 1

INTRACRANIAL HAEMORRHAGES COMPLICATING COAGULATION DISORDER (1955-1958)

Case No.	*Age*	*Coagulation disorder*	*Diagnostic criteria*	*Site and cause of haemorrhage*	*Treatment*		*Result*
					Surgical	*Haematological*	
1	62	Haemophilia	Personal and family history; brother fully studied	Subdural Traumatic	Evacuation by burr holes	Plasma transfusion	Died
2	17	Haemophilia	Personal and family history; A.H.G. assay, etc.	Intracerebral Traumatic	Evacuation by craniotomy	Plasma and blood transfusion	Died
3	3 days	Hypoprothrombinaemia; neonatal	Severe bleeding from cord and mouth. (Coagulation studies not performed)	Subdural Breech delivery	Evacuation by burr holes	Vitamin K; blood transfusion	Recovered
4	52	Hypoprothrombinaemia: cirrhosis	Multiple bruises etc.; hypoprothrombinaemia	Subdural Traumatic	Craniotomy; flap removed	Vitamin K; Blood transfusion	Recovered
5	12	Thrombocytopenic purpura	History; purpura; low platelet counts	Intracerebral Spontaneous	—	A.C.T.H.; cortisone, blood transfusion	Died
6	4	Thrombocythaemic purpura (?)	Bleeding and purpura; high platelet count, low platelet function	Subdural Traumatic	Craniotomy; flap retained; reoperation	Blood transfusion	Recovered

There are numerous other tests of the coagulation functions, but for the present study these suffice. Indeed, the surgeon concerned with a case of haemorrhagic diathesis need rarely order so great a battery of tests. Clinical study, and a judicious choice of procedure, will spare the laboratory much tedious work. The findings given by these procedures are set out in Table 2.

TABLE 2

LABORATORY TESTS IN THE COMMONER COAGULATION DISEASES

Disease	*Clotting time*	*Bleeding time*	*Platelet count*	*Capillary fragility*	*Prothrombin time (One-stage)*	*Thromboplastin generation*			*A.H.G. assay*	*Fibrinogen assay*	*Other*
						Serum factor (Christmas)	*Plasma factor (A.H.G.)*	*Platelet factor*			
Haemophilia	Prolonged except in mild cases	Normal	Normal	Normal	Normal	Normal	Deficient	Normal	Low	Normal	—
Christmas Disease	Usually prolonged	Normal	Normal	Normal	Normal	Deficient	Normal	Normal	Normal	Normal	—
"Hypoprothrombinaemia"	Prolonged except in mild cases	Normal	Normal	Occasionally positive	*Prolonged	Sometimes deficient	Normal	Normal	Normal	Low in severe liver disease	Specific tests needed to identify deficiency
Thrombocytopenic purpura	Usually normal	Prolonged	Low	Positive	Normal	Normal	Normal	Deficient	Normal	Normal	Poor clot retraction
Haemorrhagic thrombocythaemia	Usually normal	Usually prolonged	High	Sometimes positive	Normal	Normal	Normal	Usually deficient	Normal	Normal	—
Fibrinopenia	Prolonged	Normal	Normal	Normal	Prolonged	Normal	Normal	Normal	Normal	Usually low	—
Antithromboplastins	Prolonged	Normal	Normal	Normal	Prolonged	Apparently deficient			Apparently low	Normal	—
Antithrombins (e.g. heparin)	Prolonged	Normal	Normal	Normal	Prolonged	Normal	Normal	Normal	Normal	Normal	Remain active at ·90 per cent. dilution
Von Willebrand's disease	Normal	Prolonged	Normal	Often positive	Normal	?	Sometimes deficient†	Normal	Sometimes low†	Normal	—

*In some forms of hypoprothrombinaemia, the one-stage time is comparatively normal, but the two-stage prothrombin time is prolonged.
†A so far unexplained finding.

THE DISORDERS OF COAGULATION

(A) *Haemophilia* (Haemophilia A)

Nature

This is now known to be an inherited defect in A.H.G., a plasma factor requisite in the production of blood thromboplastin, and occasionally deficient in conditions other than classical haemophilia.

For the surgeon, this is the most sinister and intractable of all coagulation defects. Its victims are liable to massive internal haemorrhages even after minor injury. Still more notorious is their tendency to post-operative bleeding: not immediately, since the vascular response is good, but at an interval, and for a long time. It is well known that ordinary wound healing is usually delayed.

Relation to intracranial haemorrhage

This is one of the less common complications of haemophilia: but it is still not excessively rare. Aggeler and Lucia (1944) found in a full review of the literature four verified cases of intracerebral haemorrhage, and added a fifth. Subdural and subarachnoid bleeding has also been reported; more

recently, Jamieson (1954) has published a remarkable case of extradural haematoma. It is probable that the real incidence is higher than the literature suggests. Our series includes two cases, which are given in some detail, because they illustrate very unhappily the neurosurgical problems presented by haemophilia.

Case 1

G.K., aged 62, was admitted to the Royal Adelaide Hospital on 26th April, 1958.

Previous history: He was a known bleeder, although this fact was not at first elicited. It is likely that his disease was in a mild form; he had a history of severe dental bleeding, but had never suffered from haemarthroses. He himself had never been fully investigated, but two of his brothers are proven haemophiliacs.

Present illness: Two days earlier, he had fallen from a cart, striking his forehead. Initially he was fully conscious; there was a haematoma above the left eye, and several contusions, but otherwise he was well. On the morning of his admission he developed a right-sided hemiplegia and lapsed into coma.

Examination: When admitted, he was deeply unconscious. The left pupil was dilated and fixed to light; the right pupil was small and sluggish. There appeared to be early papilloedema. The left arm moved feebly in response to maximal pain; the right arm and leg were inert. Both plantar reflexes were extensor. The respiration was periodic.

Radiological examination of the skull showed no fracture; the pineal shadow was displaced to the right.

The provisional diagnosis was of an acute subdural or intracerebral haemorrhage. While preparations for immediate exploration were being made, the history of haemophilia was obtained. It was nevertheless decided that the patient's desperate state made operation urgently necessary.

Operation (D.A.S.): Evacuation of acute subdural haematoma (local anaesthesia). Burr holes were made in the left frontal and parietal regions. A partly solid, partly liquid haematoma was found in both sites and evacuated. Following this, the level of consciousness improved slightly, and the brain became quite slack. Towards the end of the operation, however, the intracranial pressure rose again, although irrigation from each burr hole showed no sign of renewed bleeding. It was decided that the patient's condition and the coagulation disease forbade a formal osteoplastic decompression, and the wounds were closed with drainage of the subdural space by catheters.

During and after this procedure, 1,000 cc. of fresh frozen plasma were given intravenously. It was unfortunately not possible to obtain an A.H.G. assay.

The patient's improvement was at first maintained, in that his pupillary reaction to light returned on the right and he responded better to pain. But in the following day he relapsed and died on 28th April.

Autopsy. Skull: There was no fracture.

Brain: There was very little clot over the cerebral convexity, but between the falx and the medial surface of the parietal and occipital lobes there was a massive solid haematoma compressing the diencephalon from above.

Other viscera: Nothing significant was noted.

This case was sufficiently deterring; however the patient's initial state was so bad that even without the coagulation disorder an unhappy issue might have been expected. In the second case, the surgical failure was even more unpleasant.

Case 2

W.H., aged 17, was admitted to the Royal Adelaide Hospital on 13th July, 1958.

Previous history: He was a known haemophiliac, proven by full studies. He had a long history of bleeding — at circumcision, from dental extractions, into the joints, and elsewhere. His disease was in an active phase, for he had very recently recovered from a bout of haematuria.

Two maternal uncles, and two maternal orthocousins, are known bleeders.

Present illness: Three days earlier he had been struck on the head by a football. At first, he had been unaffected by this: but on the next day he experienced severe right-sided headache, which became progressively worse. Later, he became rather drowsy, and vomited.

Examination: On admission, he was rational but drowsy. There was marked neck stiffness and Kernig's sign was positive. A left supranuclear facial paresis was noted, and both plantar reflexes were extensor.

Course: Next day the signs of a focal lesion were sharper: there was a left homonymous hemianopia, and a weakness of the left arm as well as of the face. By the third day the hemiparesis was still more marked. By the fourth day it was nearly absolute, and the patient was distinctly more drowsy. He exhibited a paresis of upward gaze, and his pulse had fallen from 72-80 to 46-50.

During this period he received daily about 1,000 cc. of fresh frozen plasma, except on the first day when he had only 500 cc. He also received a single pint of blood on 14th July: following this there was transient urticaria.

Radiological examination of the skull showed only a probable displacement of the pineal (or habenular) shadow to the left.

It was apparent that the boy harboured an expanding clot, probably intracerebral, and presumably temporal or temporo-parietal in site. After general discussion, it was decided that operation was unavoidable and carotid angiography a justifiable preliminary.

Right carotid angiography: Percutaneous puncture was carried out. There was initially no undue bleeding. The films showed great elevation of the middle cerebral artery and its branches. The pericallosal artery, and still more the deep midline veins, were displaced to the left.

Operation, 16th July (D.A.S.): Evacuation of intracerebral clot. Tracheotomy.

Under local anaesthesia (with however a skilled anaesthetist in attendance) a right temporal craniectomy was performed and the temporal lobe exposed.

It was grossly swollen, and clot was aspirated from a depth of nearly 5 cms. The clot was largely solid, and was evacuated through a small cortical incision. At first all went well. Securing haemostasis was difficult, since every surface oozed, but

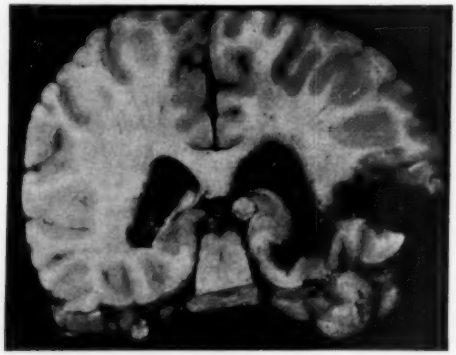


FIG. I. Coronal section through the site of operation in Case 2: showing intraventricular and post-operative bleeding, without serious cerebral compression.

with "gelfoam" and thrombin solution a fair control was obtained. However, while the wound was being closed, the brain quite abruptly began to swell and the respirations simultaneously became laboured. There was marked cyanosis.

It was then found that the trachea was obstructed by a large haematoma in the right side of the neck, in the vicinity of the angiography puncture.

After brief debate, tracheotomy was executed. The airway however remained poor until a cuffed tracheotomy tube was passed to the carina, presumably because the whole trachea was compressed. The craniectomy wound was then closed also, with drainage to the haematoma cavity and under the temporal muscle.

On the day of operation the A.H.G. level was only 10 per cent. of normal, despite the earlier infusions of plasma. For this reason, the patient was given, over a period of nine hours, 2,500 cc. of fresh frozen plasma and 2,300 cc. of fresh blood. It is unfortunately not known what level of A.H.G. was achieved by this infusion, but one may suppose that it was not high. The operative haemorrhage was mild but continuous. There was no undue shock, and the patient left the table in fair state, responsive to orders and with a clear airway. But during the night his blood pressure fell and his level of consciousness deteriorated; and five hours after his return from the theatre he died.

Autopsy. Operation site: There was only a small haematoma under the temporalis muscle.

Brain: There were no signs of gross compression, and no foraminal or tentorial herniations. On coronal section the right temporal lobe was seen to contain a large solid haematoma, occupying the operation cavity and spreading more deeply from it. There was a smaller discrete haematoma dissecting into the right optic tract. These were of recent date: but in addition there was in the adjacent brain greenish pigmentation presumably from an older haemorrhage. Finally there was a very recent solid clot in the temporal horn and vestibule of the right lateral ventricle (see Fig. I).

FIG. II. Case 2: interstitial haematoma in the anterior mediastinum, following percutaneous carotid angiography and subsequent tracheotomy. The carotid and innominate arteries have been exposed by dissection.

Thoracic viscera: There was an enormous interstitial haematoma in the anterior mediastinum (Fig. II). It extended down from the bifurcation of the right common carotid artery to the pericardium. The carotid artery had been punctured in several places, but there was no subintimal bleeding. The exact source of the cervical and mediastinal bleeding was uncertain; it was also impossible to determine whether it had caused cardiac or venous tamponade. If so, this may have been the immediate cause of death; the terminal fall in blood pressure would better accord with this than with compression by the intracranial haematoma.

However, had the patient lived longer it is very likely that intracerebral and intraventricular bleeding would have continued.

These two cases of traumatic intracranial haemorrhage complicating haemophilia appear in proper perspective when it is noted that they represent the only deaths from this disease in a period of three years. In the same period, seventeen other patients were admitted to the Royal Adelaide Hospital with various other complications of haemophilia; all were successfully treated.

Diagnosis

Is usually easy. The sufferer and his relatives are as a rule bitterly aware of the bleeding tendency. A familial history, with sex-linked inheritance and expression only in males, is usual, though sporadic cases do occur, constituting 25-30 per cent. in some published reports. The disease commonly presents in infancy and is life-long.

But three warnings should be given. First, haemophilia can exist in surprisingly mild forms (Pitney, 1957). Second, there are constitutional tendencies with familial incidence other than haemophilia. The recognition of these is now of great importance in treatment and in prognosis. Third, and for the neurosurgeon most important, is the obvious fact that a patient with an intracranial haemorrhage cannot always give a history. Our first case was admitted unconscious from a distant centre, unaccompanied by relatives; his bleeding disease was not revealed until some hours later. In any case of head injury, the interrogation of relatives is of evident importance: but it is not always possible.

The laboratory diagnosis of haemophilia is summarized in Table 2. A prolonged clotting time is usual, but may be lacking in mildly affected haemophiliacs. The thromboplastin generation test is sensitive, and almost specific; the A.H.G. assay is an index of the severity of the disease and a guide to the operative risk at any given time. Differential diagnosis will be from the other constitutional coagulation defects, and also from hereditary bleeding diathesis attributable to vascular abnormalities (von Willebrand's disease). It is to be noted that a defect in A.H.G. is sometimes seen in the latter condition.

Management

Responsible writers nearly all emphasize that surgical procedures should be avoided at almost any cost (Davidson *et alii*, 1949; Macfarlane *et alii*, 1957; Fraenkel, 1957). There are indeed a few more optimistic reports on the chances of successful intervention (Weil, 1931; Schiller *et alii*, 1948; Glaser and Freundlich, 1954), but one suspects that these writers may have been unduly fortunate in meeting the disease in its milder forms.

However there are neurosurgical emergencies in which operation is inescapable. Jamieson (1954) has reported a most encouraging case of extradural haematoma successfully evacuated by craniectomy. Laminectomies for spinal cord compression by haematoma have also been carried out (Schiller *et alii*, 1948; Macfarlane *et alii*, 1957). In these patients the indications for operation were incontestable, and the results obtained justified the very great difficulties and hazards incurred.

The general problems of surgery in haemophilia have lately been summarized by Fraenkel (1957). For the neurosurgeon faced with a haemophiliac suffering progressive cerebral compression from an intracranial clot, certain principles can be given.

1. The coagulation defect must be corrected at once. This can only be done by the transfusion of A.H.G. This is available as fresh blood, or more conveniently as plasma, which can be preserved if frozen. In either event, very large volumes must be given to raise the A.H.G. level: 30 per cent. is considered the minimum for surgical safety. It will be noted that in Case 2, daily transfusions of 1,000 cc. of fresh frozen plasma gave a level of only 10 per cent, at which even arterial puncture was catastrophic. Pitney (1959) advocates an initial transfusion of 2,500 cc. of fresh plasma, and thereafter 1,500 cc. daily.

The risks and difficulties associated with such large transfusions are apparent, especially under neurosurgical conditions. They may be reduced by an exchange technique (Jamieson, 1954) but obviously a more concentrated form of A.H.G. is desirable. The Oxford workers have used animal A.H.G.: the cow and the pig provide this in an extremely potent form, at best 8,000 times more

active than the same weight of fresh human plasma-protein. With this protection, Pennybacker has achieved an extensive laminectomy for epidural clot, as well as the successful repair of a large sloughing scalp wound. The value of animal A.H.G. has been emphasized in a series of papers from Oxford (Macfarlane *et alii*, 1957; Fraenkel, 1957), and was witnessed by one of us (D.A.S.) when working there. Unfortunately, this therapy has its own risks. Animal A.H.G. is antigenic, and after ten to fourteen days evokes sensitivity. Thereafter, allergic reactions are encountered, and it becomes increasingly difficult to obtain a satisfactory A.H.G. level. At present, neither bovine nor porcine A.H.G. is available in this country.

2. Surgical intervention should be as limited, as simple and as bloodless as possible. Haemophilia is a quantitative deficiency, and the efficiency of the coagulation mechanism will decrease still more if the demands laid on it are increased. Any procedure likely to cause deep-seated bleeding is especially dangerous, as was seen in Case 2, where the mediastinal haemorrhage certainly resulted from angiography. The ventricular haemorrhage may also have resulted from the passage of a brain needle during operation. Surface bleeding on the other hand will respond relatively well to topical coagulants, e.g. thrombin solution or "oxycel" gauze.

3. As a corollary, both angiography and ventriculography should be avoided if possible. In retrospect, one sees that the clinical signs should have sufficed in Case 2. On the other hand, failure to locate a massive clot was a contributory cause of death in Case 1 and pre-operative angiography might have obviated this. It would seem that these neuroradiological procedures should be employed where there is a real clinical doubt, and only when the A.H.G. level exceeds 30 per cent.

4. There need be no reluctance to employ general anaesthesia. Endotracheal intubation has been employed on a number of reported occasions with comparative safety; it is certainly always preferable to tracheotomy (Boyd, 1950; Macdonald *et alii*, 1953). In the desperate situation met in Case 2, when gross tracheal obstruction was causing cyanosis and cerebral herniation, the tracheotomy was temporarily life-saving; nevertheless its results were ultimately disastrous and endotracheal intubation with an incompressible tube would have been wiser.

5. Delayed post-operative bleeding will always be a danger in this disease, though neither of our patients lived long enough to manifest it. Craddock *et alii* (1948) report death from continuous slow intra-abdominal bleeding after an initially successful appendicectomy, despite repeated transfusions. In the case of spinal epidural haematoma reported by Macfarlane *et alii* (1957), the laminectomy wound underwent dehiscence in the fourth week, and extruded a large clot. Whenever possible, the A.H.G. level must be maintained until the wound is soundly healed. Haemophiliacs sometimes become resistant to continued therapy with human A.H.G., but fortunately this is a rare event.

(B) *Christmas disease* (Haemophilia B)

Nature

This rarer condition closely resembles true haemophilia in its genetic pattern and in its clinical manifestations, though on the whole it tends to take a milder course. The deficient factor is however not A.H.G. but the so-called Christmas factor, which is also occasionally lacking in other, non-familial diseases, notably severe liver damage.

Relation to intracranial haemorrhage

This complication has not, apparently, yet been reported, though it may be expected to occur. Schulman and Smith (1957) have recorded haematomyelia in an infant with a coagulation defect of this kind; laminectomy was performed, with troublesome post-operative bleeding, but the end-result is not given.

Diagnosis

The condition is distinguished from true haemophilia by the thromboplastin generation test.

Management

In broad lines, this is as for haemophilia. The Christmas factor is stable, however, and effective levels can be maintained with smaller transfusions; moreover, stored blood or plasma can be used, and serum is also suitable. A method of assay of the Christmas factor is available, but is not so necessary as a guide in treatment as is the assay of A.H.G. in true haemophilia.

On theoretical grounds, the neurosurgeon faced with an intracranial haemorrhage complicating Christmas disease can hope for a comparatively better response to planned treatment.

(C) *Hypoprothrombinaemia*

Nature

This is a haematological syndrome, rather than a disease-entity. It comprehends those conditions showing a prolonged one-stage prothrombin time, but the actual coagulation is not necessarily, nor indeed often, of prothrombin itself. Lack of factors V or VII is much more common.

The clinical diseases exhibiting hypoprothrombinaemia in this sense include:

1. Haemorrhagic disease of the newborn: basically a deficiency in vitamin K, essential in prothrombin synthesis.

2. Haemorrhagic diseases associated with jaundice and steatorrhoea. These are also related to a deficient intake of vitamin K.

3. Haemorrhagic liver disease. Severe hepatic cellular damage, as distinct from biliary obstruction, often gives a complex coagulation defect, involving factors V, VII, and prothrombin itself (Cowling, 1956). Fibrinogen deficiency may also occur in the terminal stages.

4. Therapy with the dicoumarin drugs (dicoumarin, "tromexan," "dindevan," etc.). Factor VII is usually lacking, but there are probably other defects as well (Biggs, 1956).

5. Congenital hypoprothrombinaemias are known, and may simulate haemophilia in familial occurrence. In the majority, factors V or VII are lacking, rather than prothrombin itself.

Relation to intracranial haemorrhage

Many examples are on record. Quick *et alii* (1955) mention cerebral haemorrhage in a case of idiopathic factor VII deficiency. Cerebral haemorrhage has complicated the use, therapeutic or accidental, of dicoumarin and allied drugs (Duff and Shull, 1949; Chalgren, 1953). Such bleeding has usually been apoplectiform, and there have been no opportunities for surgical treatment. However, with the prevalent use of these drugs in the long-term management of coronary and cerebral arterial disease, we may expect occasional cases of progressive intracranial bleeding in patients ambulant on anticoagulant therapy. If the bleeding follows head injury, the coagulation defect may conceivably be missed.

The relationship between neonatal intracranial haemorrhages and hypoprothrombinaemia is uncertain. It was at first supposed that a high proportion result from a coagulation defect. This view is still held by some authorities. Gröntoft (1954) believes that the antenatal administration of vitamin K has significantly lowered the incidence of subdural haematomata; on the other hand, Potter (1945) found no such relationship. Ingraham and Matson (1954) consider bleeding diatheses a rare cause of infantile subdural effusions. The question is complicated by the discovery that at birth there is a physiological deficiency of prothrombin (and of other coagulation factors) which cannot be prevented by antenatal vitamin K. Our Case 3 (Table 1) was not investigated by coagulation tests before transfusion and the administration of vitamin K had rectified her gross bleeding tendency. It seems however reasonable to consider her in this context. She presented with exsanguinating haemorrhage from the umbilical cord and from the mouth, on the third day after birth. Signs of cerebral bleeding appeared soon after. Blood transfusion restored her general condition, but the fontanelle remained tense. On the eighteenth day, bilateral subdural effusions were discovered by fontanelle puncture; they were later evacuated by burr holes (D.A.S.), but osteoplastic craniotomy was not required.

Case 4 in our series provides a good example of subdural haemorrhage in hypoprothrombinaemia secondary to liver damage. Intervention was successful, though the patient later died of primary liver disease.

Case 4

G.M., aged 52, was admitted to the Royal Adelaide Hospital on 23rd July, 1957.

Previous history: She was a known alcoholic and hepatic cirrhosis had been diagnosed earlier.

Present illness: Ten days before her admission she had fallen down stairs. The sequence of events thereafter is unclear: on the day of her admission she had had a series of left-sided focal motor fits, and following these she was admitted in coma.

Examination: Shortly after her admission she regained partial consciousness. She exhibited general exaggeration of tendon jerks, and both plantar reflexes were extensor. She was moderately jaundiced. The liver was enlarged and hard. There were numerous subcutaneous bruises and petechial haemorrhages; her saliva was blood-stained.

Laboratory tests: There was a normocytic anaemia (71 per cent. Sahli). The platelet count was depressed (90,000 on 25th July; 50,000 on 30th July). The icteric index was raised and biochemical tests showed a gross impairment of hepatic cellular function. The one-stage prothrombin time was initially 27 per cent. of normal (25th July).

Course: It was at first suspected that the cerebral disturbance was due to hepatic encephalopathy. Intramuscular vitamin K_1 ("menadione" 75 mgm.) was given, and the prothrombin time improved: 29th July (36 per cent.), 1st August (71 per cent.), 2nd August (41 per cent.).

In the week following her admission, the neurological state fluctuated. By 1st August, she could co-operate well in tests and was fairly well oriented, with however a tendency to confabulate when her memory was tested. The pupils were sluggish in response to light, and there was ill-sustained nystagmus, with ptosis. Ophthalmological examination showed no papilloedema, but on the right a single retinal haemorrhage was seen. All tendon jerks were exaggerated, and the plantar reflexes were extensor. At this stage the suspicion of Wernicke's encephalopathy was entertained.

Radiological examination of the skull showed however a distinct shift of the pineal calcification to the left.

The diagnosis of a subdural haematoma associated with hepatic hypoprothrombinaemia was now made. During the night, 1st-2nd August, the patient again became stuporose.

Right carotid angiography (percutaneous) showed displacement of the midline vessels to the left, with inward displacement from the skull of the cortical vessels. This excluded an intra-cerebral clot, and confirmed the diagnosis of a subdural collection.

Operation, 2nd August (D.A.S.): This was begun under local anaesthesia and completed with intravenous thiopentone and endotracheal nitrous oxide. To diminish the bleeding tendency, two pints of blood were transfused. Intravenous vitamin K was also given.

Burr holes in the right parietal and temporal areas established the presence of a large partly solid subdural haematoma. Adequate evacuation was not possible, and a right frontal osteoplastic flap was therefore reflected.

Inordinate difficulty was met from oozing haemorrhage from the dural surface. When this was overcome, the dura was incised and a typical subdural haematoma found and removed. It was most extensive in the Sylvian region. The bone flap was removed and placed in the bone bank.

Post-operative course: This was stormy. The prothrombin time remained low: 12th August (34 per cent.), 15th August (27 per cent.).

There was a good deal of bleeding under the scalp flap; this was controlled by repeated aspirations. The neurological state changed little in the first week and then slowly improved. By 20th August, she was oriented and able to go home, though still jaundiced. She remained surprisingly well for the next two months, but the jaundice persisted and she was re-admitted on 5th November, 1957, in terminal liver failure from which she died. Autopsy was refused.

Liver disease appears to be one of the commoner causes of hypoprothrombinaemia presenting with neurological complications. We have treated another case, not included in this series, where the bleeding was intracerebral. The cause of the hypoprothrombinaemia was liver damage from "marsilid" poisoning, and after correction of the coagulation defect the haematoma was successfully evacuated by aspiration.

Diagnosis

In the neonatal period, intracranial haemorrhage is common, and the instability of the coagulation factors at that age makes laboratory tests of less value. Bleeding from other parts of the body points to a coagulation defect, but this need not necessarily involve prothrombin; other diseases, notably haemophilia, may present as neonatal haemorrhage, and these will of course show no response to vitamin K.

When there is biliary obstruction, steatorrhoea or frank liver disease, the suspicion of hypoprothrombinaemia arises and is easily verified. Intracranial haemorrhage supervening under these conditions needs however to be distinguished from the other neurological complications of liver disease, notably metabolic encephalopathy.

The congenital hypoprothrombinaemias, usually deficiencies of factors V or VII, will be suspected when a constitutional bleeding tendency, perhaps clinically simulating haemophilia, is associated with a low one-stage prothrombin time. Special tests are required to isolate the exact deficiency.

Diagnostic difficulty should not arise when the hypoprothrombinaemia results from anticoagulant drugs, except as stated earlier, conceivably in the unconscious patient. It may be wise for patients maintained on anticoagulant therapy to carry cards stating their treatment.

Management

Our experiences, and the report of Littmann and Brodmann (1955), suggest that surgical risks will usually be tolerable, unless the hypoprothrombinaemia is of exceptionally high grade. Nevertheless, every effort to diminish the coagulation defect should be made.

1. Vitamin K alone is curative in haemorrhagic disease of the newborn and in the hypoprothrombinaemia of steatorrhoea or biliary obstruction. (In these latter conditions the vitamin must of course be given by injection.) To reverse the action of the dicoumarin drugs, a fresh blood transfusion is more reliable and more immediately effective; it can usefully be followed by vitamin K_1 therapy. Vitamin K_1 can be given either orally or intravenously; toxic reactions have been reported, and it is recommended that doses in excess of 50 mgm. daily should not be given. In infants, 4 mgm. daily is considered adequate.

2. Congenital deficiencies of factors V and VII do not respond to vitamin K therapy, nor as a rule does the bleeding tendency of severe liver damage. Transfusion of fresh blood or plasma is the only means of correction. Biggs and Macfarlane (1957) emphasize that the volumes given must be large. A major orthopaedic procedure was however recently carried out at the Royal Adelaide Hospital on a case of congenital factor VII deficiency, under cover of daily transfusions of only one pint of plasma.

3. The prothrombin time may be used as a guide to operative safety; perhaps 30 per cent. is the minimum level acceptable. The one-stage method is usually held adequate, but Donald *et alii* (1954) describe cases in which it was a poor index of the haemorrhagic risk. This appears especially true of the hypoprothrombinaemia of liver disease, and it is noteworthy that our Case 4 had a severe bleeding tendency at a one-stage prothrombin level of 34 per cent. Possibly a two-stage test would have shown a greater depression.

(D) *Thrombocytopenia and other platelet defects*

Nature

There are a number of bleeding disorders resulting from inadequacy in the platelets. In some, there is a reduction in the number of platelets; in others, platelets are plentiful but incompetent. In many of these conditions, there is an associated deficiency in the smaller vessels, especially the capillaries, with impairment in the vascular component of haemostasis.

1. Primary thrombocytopenic purpura is the best known. Here the bleeding tendency expresses deficiency both in coagulation and in the vascular response. In some cases, the patient apparently develops an immune reaction against his own platelets and vascular endothelium. The clotting defect can be demonstrated, and quantitatively assayed, by a modification of the thromboplastin generation test (Bonnin, 1957). Clot retraction is also defective and of course the platelet count is very low. The vascular defect gives rise to spontaneous purpuric haemorrhages (not usually seen in the diseases discussed earlier), to a positive capillary fragility test, and as a rule to a prolonged bleeding time.

2. Secondary thrombocytopenic purpuras are found in association with a variety of conditions: severe blood dyscrasias such as leukaemia; the "hypersplenic" syndrome associated with splenomegaly; acute bacterial or viral infections; reactions to various drugs, including sulphonamides, barbiturates, "sedormid," quinine, etc. The resultant haemorrhagic syndrome is very similar to that of idiopathic thrombocytopenia.

3. There is also a group of bleeding diseases in which the platelets are in sufficient numbers, but exhibit a qualitative defect in function. The condition may rarely be hereditary, or may be associated with acquired disease (e.g. leukaemia, polycythaemia). These cases can be grouped under the designation thrombasthenia.

4. Finally there is the condition of haemorrhagic thrombocythaemia. In this disease the platelet count is abnormally high, but the platelet function may be very defective. It is generally regarded as a myeloproliferative disease, akin to polycythaemia vera myelofibrosis, and possibly myeloid leukaemia. The precise cause of the bleeding tendency is unknown, but it appears to be some more complex state than a pure disorder of platelet thromboplastic function.

Relation to intracranial haemorrhage

These diseases probably account for more cases of intracranial haemorrhage than all the other coagulation disorders together. Thrombocytopenic purpura often terminates with intracranial bleeding, whether subarachnoid subdural (Evans and Perry, 1943), or intracerebral, as in our Case 5.

Case 5

S.G., a girl aged twelve, was transferred to the Royal Adelaide Hospital from another centre on 29th July, 1955.

History: For the previous two years she had had recurrent epistaxes, bleeding from the gums, and bruising on minimal trauma.

Laboratory tests: Her platelet count was persistently under 50,000. The platelet thromboplastic function was 18 per cent. of normal. Other haematological tests were not contributory.

Course: She had been treated elsewhere with A.C.T.H. (100 mgm. daily in divided intramuscular doses, for four days), oral cortisone (100 mgm. daily for the next nine days) and repeated blood transfusion. No remission was obtained.

While under study, she developed severe headache and began to vomit. There were signs of meningism, and later a progressive left-sided hemiplegia. She died four days after the onset of cerebral symptoms, despite blood transfusion and continued cortisone (150 mgm. daily: later increased to 200 mgm. daily).

Autopsy: This disclosed extensive subarachnoid haemorrhage, a thin subdural haematoma and a massive intracerebral haemorrhage in the temporoparietal region.

Intracranial haemorrhage is indeed said to be the commonest cause of death in primary thrombocytopenic purpura and is a well-known complication of the secondary purpuras (Chalgren, 1953). Cerebral haemorrhage is not at all infrequent as a terminal event in leukaemia. Haemorrhagic thrombocythaemia is a rare disease, but it appears that it can also predispose to intracranial haemorrhage. Our Case 6 presented with an acute post-traumatic subdural haematoma. It was successfully evacuated by osteoplastic craniotomy. She developed a massive post-operative extradural haematoma, and this coupled with the observation of continued bleeding from needle punctures aroused the suspicion of a haemorrhagic tendency. There was no previous history of undue bleeding. The bleeding and clotting times were normal, but the platelet count was found to be 830,000/cu.mm., and the thromboplastin generation test confirmed a defect in platelet function. The patient has made a complete recovery and the cause of her transient thrombocythaemia remains obscure.

In many of the recorded cases of intracranial haemorrhage complicating these purpuric diseases, the onset has been apoplectiform. But in some, the course has been more protracted, as in our Cases 5 and 6. It is not always possible to determine whether the bleeding has been spontaneous or induced by trauma; probably the vascular defect makes spontaneous haemorrhage much more common than in the pure coagulation diseases.

Diagnosis

There is usually a clear history of the bleeding tendency. Cases presenting with intracranial haemorrhage as a first symptom are however on record (Gitt and Weiss, 1940; Evans and Perry, 1943). In these clinical examination will usually show purpuric haemorrhages elsewhere, indicating the need for laboratory investigation (see Table 2).

It must be reiterated that these diseases are only in part defects of coagulation. The important factor of vascular fragility is not the subject of the present report: but it governs the differential diagnosis of patients presenting with a prolonged bleeding time. Some patients so affected will exhibit defects of platelet function, as discussed here. Others however may have a constitutional or acquired defect purely of the capillaries. Scurvy is an example of the latter. Constitutional capillary defects are often familial, and go under the name of Von Willebrand's disease. These are not uncommon; indeed, Pitney (1959) regards them as the most frequent type of bleeding defect in his practice. However, the bleeding tendency is rarely severe.

Management

Where the intracranial haemorrhage complicates a lethal disease like leukaemia, or when it is massive and apoplectiform, no one will wish to intervene. But when the basic disease is possibly curable, as in the primary and secondary thrombocytopenias, something can be attempted.

1. Transfusion. Platelets can be transfused, either as a specially prepared suspension, or as fresh whole blood. Our experience

with this as a temporary corrective is not very encouraging. In three instances where imperative surgery (not neurological) was covered with concentrated platelet infusions, the operative bleeding was controlled, but in all three cases there was troublesome bleeding before other measures to relieve thrombocytopenia became effective. The neurosurgeon cannot therefore expect normal post-operative haemostasis under these conditions.

2. Cortisone and A.C.T.H. have induced remissions in many cases of idiopathic thrombocytopenic purpura and in some cases of secondary purpura. There are now many reports on this therapy, and it appears that in acute forms of idiopathic thrombocytopenia, it is the treatment of first choice. In chronic cases, the response is less certain, and relapses are more common.

3. Splenectomy remains the most effective remedy in chronic idiopathic thrombocytopenic purpura, and is usually advocated where steroid therapy fails. It has been successfully carried out on a patient manifesting continued subarachnoid bleeding (Gitt and Weiss, 1940). The response is very rapid (Robson, 1949), and we urge early splenectomy when cerebral haemorrhage supervenes: trial of steroid therapy may, as in our Case 5, lose what little chance there is of arresting the bleeding.

4. The place for surgical evacuation of intracranial haematoma is not easy to determine. One of us (H.N.R.) has seen an attempt of this kind performed immediately after an emergency splenectomy. Haemostasis was extremely difficult, further intracranial bleeding occurred, and the patient died about twenty-four hours later. Where possible, intracranial surgery should be delayed until the response to surgery is fully established, usually about the fourth or fifth day. If earlier intervention seems imperative, the surgeon may reasonably demand evidence that the splenectomy has been at least partially effective, as judged by a normal bleeding time and capillary test, and still more a rising platelet thromboplastic function. Bonnin (1957) suggests that this last should be above 30 per cent. if abnormal bleeding is to be avoided.

(E) *Fibrinogen deficiencies*

Nature

Congenital absence of fibrinogen is a rare condition. It is often familial, clinically resembling haemophilia save in that the sexes are equally affected. The manifestations of the disease are often remarkably mild.

Acquired fibrinogen deficiency is much more common. It has been seen in various severe liver diseases, where production is presumably impaired. It may also result from defibrination. This is seen in obstetrical conditions involving placental necrosis, and also as a complication of certain surgical procedures, especially pulmonary resections. Apparently under these circumstances a thromboplastic agent is liberated in the blood stream, causing general intravascular mural thrombosis, which denudes the blood of its fibrinogen, and also evokes the formation of circulating fibrinolysins.

Relation to intracranial haemorrhage

Cerebral and subdural haemorrhages were reported in association with congenital afibrinogenaemia by Schönholzer (1939). We have no experience of comparable nature.

Diagnosis

In the rare constitutional form, the diagnosis is from haemophilia and other less common congenital coagulation defects. In afibrinogenaemia, the blood will be incoagulable, both in tests of clotting time and in the one-stage prothrombin assay. It will not clot if fresh thrombin is added to it; special procedures will demonstrate the specific deficiency in fibrinogen.

In the defibrination syndrome the diagnosis will usually be apparent. Nevertheless, full laboratory tests are to be done, because in this condition other important coagulation factors (including A.H.G.) may also be deficient.

Management

We have no personal experience of neurosurgical intervention in the presence of a fibrinogen deficiency. From reports, it seems that small transfusions of pure fibrinogen are most effective; but in an emergency whole blood can be given. (See addendum)

(F) *Anticoagulants: antithrombins and antithromboplastins*

Nature

There are rare bleeding diatheses in which the fault is not a deficiency, but a circulating anticoagulant, antagonistic either to thrombin or to thromboplastin. Heparin has the first action, and there are reports of naturally occurring haemorrhagic states apparently due to this, or a very similar, substance. Far more common of course is the iatrogenic haemorrhagic state produced by over-use of heparin. Natural antithromboplastins have also been reported, especially in puerperal women, producing a state resembling haemophilia. Haemophiliacs may also themselves acquire circulating anticoagulants, if they become sensitized against A.H.G. by transfusion; fortunately this is a rare event.

Relation to intracranial haemorrhage

There are many reports of cerebral haemorrhage complicating heparin therapy; this complication is especially likely if there is coincident cerebral vascular disease, as for instance in subacute bacterial endocarditis (Chalgren, 1953). We have seen fatal haemorrhage from a metastatic melanoma in the brain, taking place while heparin, under a wrong diagnosis, was being given.

Diagnosis

This will present difficulties when the circulating anticoagulant develops spontaneously. This may occur under unexpected circumstances. We recently saw a patient with advanced hepatic cirrhosis and cerebral softening where coagulation defect was not the anticipated hypoprothrombinaemia, but due to a circulating antithrombin resembling heparin. The presence of such substances can usually be demonstrated by the fact that small amounts (as little as 10 per cent.) of the patient's plasma will significantly prolong the clotting time of normal plasma.

Management

We have not met the need for neurosurgical treatment in such conditions. The action of heparin and of the naturally occurring antithrombins resembling heparin can be immediately stopped by intravenous protamine sulphate (5 ml. of 1 per cent. solution) repeated as necessary. No specific antidote to the antithromboplastic substances is available.

DISCUSSION

The intracranial haemorrhages associated with disorders of blood coagulation may result from trauma, often of only minor degree. They may at times appear to be spontaneous: when this is so, there may be associated vascular disease, or perhaps there has been an unremembered head injury. It is not always possible to make the distinction, and whether spontaneous or traumatic, an intracranial haemorrhage complicating defective coagulation is a most formidable illness.

This association, though not common, is certainly no rarity. We have collected six examples in the practice of one small unit over a period of three years, and have noted many more in the literature of the last twenty years. Very few of the records mention neurosurgical intervention. In many cases, the bleeding appears to have been catastrophic, and operation would clearly have been impossible. This however is not always so. There are reports of progressive bleeding, in some cases situated superficially, either in the subdural or extradural planes. Progressive cerebral compression from haemorrhage in these sites, occurring in the absence of a coagulation defect, is usually remediable by operation. Even intracerebral clots can often be evacuated successfully, if their situation and rate of evolution be favourable. It is therefore necessary to decide whether the coagulation defect itself prohibits operation.

The defects considered here fall into three groups. First, there are those in which the coagulation defect results from some general disease which will certainly prove fatal before very long, irrespective of any intracranial complication. This is true where the bleeding tendency results from leukaemia, or from terminal liver disease. Here, intervention is clearly futile. Our laborious evacuation of a subdural haematoma complicating severe hepatic cirrhosis gained the patient only three months. Second, there are coagulation defects which are essentially temporary and recoverable. Such are the hypoprothrombinaemias of dicoumarin therapy and of vitamin K deficiency. Many cases of thrombocytopenic purpura are in this category. Here, there can be no doubt that every effort is justified. Third, there are constitutional coagulation defects, incurable but

compatible with long life. Haemophilia is the chief of these. Most surgeons will feel that the prognosis in these diseases warrants determined treatment of the complications.

The difficulties presented by defective natural haemostasis are however enormous. If there is any neurosurgical adventure more unpleasant than an operation on a severe haemophiliac, we have yet to meet it. All responsible authorities urge that operation should be avoided wherever possible, with haemophilia and with any other coagulation defect not readily reversed by corrective or substitution therapy. This is not merely because the actual operation can be difficult and, if prolonged, immediately dangerous. It is still more because of the certainty of post-operative bleeding. Every neurosurgeon encounters this complication often enough under ordinary circumstances; in an uncorrected severe coagulation defect one can be confident that it will occur, usually on a disastrous scale. Nevertheless, however convinced one is of the dangers of operation, there are occasions when something must be attempted.

There are also occasions when the neurosurgeon may operate unawares on a patient with an unrecognized bleeding tendency. This may happen when the patient is admitted unconscious after head injury, without accompanying relative or friend, as in our Case 1. It also rarely happens that intracranial haemorrhage is the presenting symptom of a blood dyscrasia. This has been reported with thrombocytopenic purpura (Gitt and Weiss, 1940; Evans and Perry, 1943). Such diagnostic ambuscades will often be avoidable, if the history is properly taken and the general examination careful. But there will always be some errors of this kind, since deepening coma after cranial trauma will not wait for leisured retrospective enquiries.

Both the calculated risk incurred in a known coagulation defect, and the unexpected risk taken by misadventure, can be reduced. For this, the close collaboration of haematologist and neurosurgeon is essential. These two disciplines have ordinarily little commerce, and the present survey is an attempt to present to each the other's problems.

If there is clinical suspicion of a bleeding tendency, there must be as full an investigation as the urgency of the case permits. The tests commonly useful have been described; expert opinion will often reduce the number necessary. When a specific coagulation defect is found, or reasonably suspected, every effort must be taken to correct it at once. This is so even when it is hoped to avoid operation; it is absolutely imperative if any surgical procedures including diagnostic measures such as angiography, are contemplated.

Most of the major coagulation diseases are at present incurable. The chief exception is hypoprothrombinaemia due to avitaminosis K: here the remedy is so rapidly efficient that haemorrhagic disease of the newborn is a very minor neurological problem. Haemophilia and the rarer constitutional coagulation defects (Christmas disease, congenital defects in factors V and VII, afibrinogenaemia, etc.) are only controlled by substitution therapy. This is easier if the exact deficiency is known; as A.H.G. and other specific factors become available in concentrated form, the importance of precise diagnosis will increase. At present, the rarer states will usually be treated by transfusion with fresh blood or plasma, and in general they seem to respond comparatively well. True haemophilia requires very massive therapy, especially in so considerable an operation as craniotomy. If A.H.G. is not available in concentrated form, an exchange transfusion with fresh blood or fresh plasma is recommended. It is not enough merely to bolster the pre-operative A.H.G. level to an adequate minimum (30 per cent. of normal): one must maintain it for some days. Haematologists accustomed to lesser exigencies, such as dental extraction, may under-estimate the demands of a craniotomy. They may also forget the special dangers of rapid transfusion in patients suffering from cerebral oedema. Neurosurgeons on the other hand are apt to ignore the great technical difficulties involved in the exact haematological control of haemophilia and similar conditions. Such control is possible only in very well equipped laboratories with a numerous staff. When time allows, there is everything to be said for transfer of such cases to a special centre. This system was adopted with several of the haemophiliacs treated in Oxford by Macfarlane *et alii* (1957) and should be practicable in Australia. Even where the laboratory facilities

are ideal, however, the surgeon must appreciate that tests at any one time may not exactly reflect the operative risks. There is great variability in the behaviour of haemophilia, and the allied diseases: from causes as yet unknown, a bleeding tendency may fluctuate remarkably.

The purpuric diseases present diverse problems involving the factor of vascular fragility as well as coagulation defects proper. Some of these conditions are relatively trivial, and should be recognized as such: this is true of some of the miscellaneous constitutional vascular deficiencies loosely grouped as Von Willebrand's disease. Pitney (1959) stresses the frequency of spontaneous remissions in these states. Thrombocytopenic purpura, primary or secondary, is however a very formidable condition. If intracranial haemorrhage supervenes in idiopathic thrombocytopenia, there is strong warrant for immediate splenectomy: subarachnoid bleeding may cease, as in the case recorded by Gitt and Weiss (1940), and even intracerebral haemorrhage may recover (Chalgren, 1953). It appears at present that steroid therapy is less trustworthy. Whether, when cerebral compression is established, one should attempt surgical evacuation, is less certain; it should be lifesaving with superficial collections producing progressive compression, but reports of success under such circumstances are ominously few (cf. Evans and Perry, 1943).

When a cranial operation is attempted in the presence of a coagulation defect, special care should be taken in operatve technique. Every haemostatic aid is requisite; diathermy, suturing, wax, and the coagulant preparations should be used with the utmost thoroughness. Theoretically, and in our surgical practice, topical thrombin solutions and "oxycel" gauze are effective in haemophilia and hypoprothrombinaemia: presumably they would be inert in the presence of a fibrinogen deficiency.

As a precaution against post-operative cerebral compression by continued ooze, we recommend massive decompression by bone resection; the removal of the bone flap is suggested if an osteoplastic craniotomy is necessary. (This step seemed helpful in our Case 4; it was omitted in Case 6, and reoperation was necessary.) Such decompression is much more effective than any kind of drainage: even in extremely severe haemophilia, there is usually enough clot formation to block a drainage tube.

SUMMARY

1. The chief disorders of blood coagulation are discussed as predisposing or complicating factors in intracranial haemorrhage.
2. Six cases of intracranial haemorrhage associated with various coagulation defects (haemophilia, hypoprothrombinaemia, and platelet deficiencies) are presented. Their management is discussed.
3. If the coagulation defect can be corrected or controlled, there is a reasonable possibility that surgical evacuation may be successful, especially when the haematoma is superficially situated.

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The substance of this paper was communicated to a meeting of the Australasian Society of Neurosurgeons on 9th November, 1958.

ADDENDUM

Since the preparation of this paper, the writers have seen two other cases of intracranial haemorrhage complicating grave coagulation defects. Both were fatal.

One, to be published fully elsewhere, was an infant aged six weeks. He presented with an acute subdural haematoma resulting from minor injury. A story of abnormal bleeding since the seventh day of life was elicited. Ther was no evidence of familial predisposition. The clotting time and prothrombin time were *both* markedly prolonged; subsequent studies by Dr. N. D. Hicks of the Institute of Medical and Veterinary Science (to be published) establish a combined deficiency of factor VII and the Christmas factor. Despite surgical evacuation of the haematoma and infusion of fresh frozen plasma, the infant died, chiefly from exsanguination.

The second patient, aged 56, also exhibited multiple coagulation defects. He had been treated for a recent severe coronary occlusion with Dindevan (100 mgm. 12 hourly for three doses) and for peripheral venous thrombosis with Butazolidine (100 mgm. 6 hourly), intermittently over a period of some weeks. Perhaps from the combined effects of these drugs, his prothrombin level was unusually labile, and fell below 5 per cent. He then had a spontaneous subarachnoid haemorrhage, and after an initial recovery, relapsed with signs of a lesion of the left cerebral hemisphere. Vitamin K was administered. Surgical exploration by burr holes was carried out when the prothrombin level had reached 53 per cent. Despite this satisfactory figure, there was inordinate bleeding during and after operation. Further laboratory investigation then revealed that, in addition to the hypoprothrombinaemia, there was a very gross defect in fibrinogen (level .09 gm. 100 ml., the normal range being .120-.380 gm. 100 ml.). Intravenous injection of pure fibrinogen (5 gm.) did not fully control the bleeding tendency; the patient died of a massive intracerebral haemorrhage. Autopsy confirmed this diagnosis, and that of myocardial infarction; no evidence of liver disease was found.

These two cases illustrate the need for full investigation in any bleeding tendency: multiple deficiencies are not rare, and correction of one defect may leave untreated some other grave disorder. The first case shows how serious these intracranial haemorrhages are in infancy: although the operative blood loss did not appear great, it was too much for the enfeebled infant. The second case demonstrates the occasional dangers of anticoagulant therapy: we will doubtless see more such cases.

We are obliged to the Boards of the Adelaide Children's Hospital and the Queen Elizabeth Hospital for permission to publish these cases.

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SARCOMA IN PAGET'S DISEASE OF BONE

By Hugh C. Barry

Sydney

THE development of sarcoma in people suffering from osteitis deformans was described by Paget himself (1882) and has been confirmed since by many writers. There has been wide divergence of opinion concerning not only the incidence of Paget's disease in the community, but also the chance of malignant change developing. For example, in China Paget's disease is very rare. This has been noted by Snapper (1949) and was confirmed in a visit there recently. In England, where osteitis deformans is common, the general attitude to treatment and this risk of malignancy is similar to our own in Australia. In the United States, on the other hand, I have noted that each case of Paget's disease is suspected as being potentially malignant and the incidence of sarcoma has been reported to be as high as 10 per cent. (Coley, 1949). Recently, however, Porretta, Dahlin and Janes (1957) from the records of the Mayo Clinic found only 16 cases of bone sarcoma among 1,753 patients with Paget's disease, an incidence of 0.9 per cent. They also reviewed a total of 128 cases of this type of sarcoma, which have been reported in the English literature. In order to study the incidence and nature of sarcoma arising in Paget's disease in Australia, the records of the four teaching hospitals in Sydney during the last ten years have been reviewed. Twenty-nine cases of sarcoma developing in Paget's disease have been collected including five who have been treated by or under the supervision of the author.

In Sydney, osteitis deformans is uncommon under 40 years of age, but beyond this age the incidence steadily increases throughout the community. It is so widespread in elderly people that an accurate assessment is impossible. Very few cases present because of the disease or its complications, but the X-ray changes, either local or general, are commonly seen in routine investigations. It is often thought inadvisable to report the finding to the individual. Those that are admitted to hospital as the result of the disease itself are usually suffering from fractures of the femoral shaft and the majority of these occur at the subtrochanteric level. Usually these patients have had no previous symptoms or signs to suggest that any bone disorder was present. There must be many in whom the disease is present, but never recognized. In the records available, men are slightly more often affected than women. Sear (1949) with an extensive experience of radiology in Sydney, placed the incidence of malignant change at 2 per cent. This is much lower than many authors from overseas have quoted, but I think it is still too high. My impression is that it is not more than 1 per cent. and probably less. This makes the risk of sarcoma of little practical significance, especially as no useful treatment is yet available and the change usually develops when normal expectation of life is short.

The clinical findings in 29 cases of sarcoma are summarized in the accompanying table. There were 11 females, 18 males and the average age was 64.5 years. The youngest case was a man aged 50 years. Certain other aspects of this series require further consideration and five personal cases are reported more fully.

One of the interesting features of the Sydney series is that the sarcoma developed in the humerus or scapula in 9 out of 29 cases. This confirms the high incidence in the humerus as reported by others (Summey and Pressly, 1946; Lake, 1951; Poretta, Dahlin and Janes, 1957). This is noteworthy because the changes of osteitis deformans are usually most marked in the pelvis, lumbar spine, femora and skull and the bones of the shoulder girdle often escape. In several cases the sarcoma did not arise in bone obviously affected by Paget's disease as seen in radiographs, although the changes were widespread and advanced in other parts of the skeleton. Further examination showed that the bone at the site of the sarcoma was the seat of osteitis deformans. It seems likely that a careful examination of the skeleton would usually indicate that the changes of osteitis

deformans are much more widespread than the X-ray findings suggest. This has recently been shown by Collins (1956). It is tempting to infer that at least some of the cases of primary bone sarcoma arising in elderly patients without any obvious cause may be due to Paget's disease which is still not evident in X-rays and therefore not diagnosed. Several such cases have been noted when collecting this series.

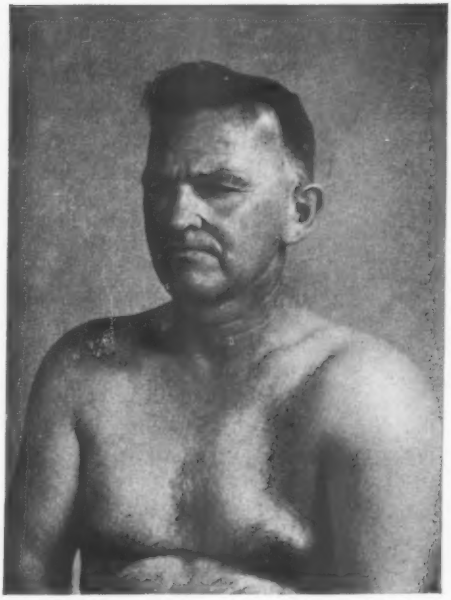

FIG. I. Case 10. Aged 50 years. Sarcoma of upper end of left humerus with secondary tumours in skull. See also Figs. II and III.

FIG. II. Case 10. X-ray of skull showing changes of Paget's disease and several discrete osteolytic lesions at site of soft tissue tumours.

In some cases, multiple sarcomatous lesions develop and it is impossible, even at autopsy, to decide if they are secondary to a single focus or are in fact, multiple primary malignant changes. These tumours have been noted in the pelvis, spine and ribs, but there is a special predilection for them to form in the skull where they may be multiple. This has been noted in 6 cases in this series and it gives rise to a typical clinical syndrome (see Fig. I). It suggests that the bone in the calvarium is often in a pre-malignant state and once activated in some way sarcoma can develop rapidly in several sites at once. The tumours feel soft and increase steadily in size, but death has always occurred in this series before any fungation developed. They may be associated with well defined osteolytic areas in the skull as seen in X-rays (see Fig. II).

In this series sarcoma developed in 5 cases following definite local trauma and this suggests that an injury may sometimes play a part in initiating the malignant change. Several other cases were associated with fractures at the site of the lesion. It is usually impossible, however, to be sure that the bone in such cases had not already been weakened by some new pathological change. Two cases seen personally shortly after sustaining a fracture of the femoral shaft were found to have a large sarcomatous area and only a recent crack fracture through the remaining portion of the shaft. It is also worth noting that only one case in this series developed in the subtrochanteric area and yet this is the common site for fractures to occur. On the other hand, following a recent fracture through bone affected with Paget's disease, I have noted the development of a widespread rarified area as shown in X-ray films and the

same appearance developed once after inserting an intramedullary nail in the femur. These X-ray signs suggest that a malignant change may be developing, but in my own experience it has not occurred. Nor has a sarcoma ever developed following an osteotomy or a bone grafting operation during the period that this series in Sydney was collected.

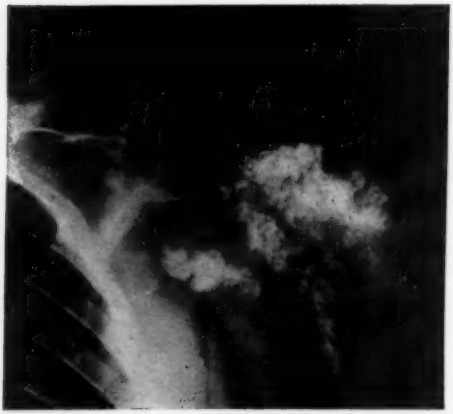

FIG. III. Case 10. X-ray of shoulder showing sarcoma of upper end of humerus.

FIG. IV. Case 2. X-ray of left shoulder showing sarcoma of upper end of humerus with Paget's disease of bone. Patient survived three years and eight months.

With regard to the microscopic appearance of these tumours, several writers have noted that the sarcomata developing in bone affected by Paget's disease do not conform to any particular histological entity. Although the majority have been classified as osteogenic sarcoma, others have been reported as chondrosarcoma, fibrosarcoma and even giant cell tumour (Russell, 1949). A careful pathological review of the cases in the records of

FIG. V. Case 21. X-ray of lower end of femur showing changes of Paget's disease, localized bone destriction, recent pathological fracture and large oval soft tissue swelling.

the Middlesex Hospital has recently been carried out by Thomson and Turner Warwick (1955). Out of 17 cases of sarcoma developing in Paget's disease, 5 were classified as osteosarcoma, 6 as chondrosarcoma, 4 as fibrosarcoma and 2 as giant cell sarcoma. In 3 of their cases the skull was involved. In the Sydney series, the majority was considered to be typical osteogenic sarcoma, but examples of chondrosarcoma and fibrosarcoma have also been noted. An example of giant cell tumour arising in this way was reported by Keon-Cohen at the Australian Orthopaedic

Association meeting in Adelaide in 1957, but no case has been found in this series in Sydney.

FIG. VI. Case 22. X-ray of same femur as Fig. V taken two years later. Shows sclerosis at old fracture site and disappearance of soft tissue swelling. Patient lived nearly eight years after pathological fracture.

Treatment has consisted of amputation (6 cases), deep X-ray therapy in most and only palliative measures in a few advanced cases. Two mid-thigh amputations showed recurrence in the stump. Most patients were unaffected by any treatment and died within six months. Two cases survived three years eight months and seven and one-half years respectively. Five cases, including the two above, were under my supervision for some time and are reported in more detail below. Cases surviving more than five years have been reported by Sherman and Soong (1954) and recently by Cowie, Barr and Dudley (1958) and Stevens and Lennox (1958).

Case 1

C.McG., male, aged 56. Admitted to Canterbury District Hospital on the 24th February, 1948, under Mr. L. G. Teece. Had had pain in left shoulder for eighteen months. X-ray showed sarcoma of upper end of humerus. Biopsy was reported as "sclerosing osteogenic sarcoma present with Paget's disease of bone" (Keith Inglis). Advised forequarter amputation, but refused and was referred to deep X-ray department at Royal Prince Alfred Hospital. Developed large metasteses in chest as seen by X-ray, but no changes in skull. Tumour of shoulder slowly increased in size, but patient remained remarkably comfortable and was last seen three years eight months after diagnosis was made (see Fig. IV).

FIG. VII. Case 24. Female aged 70. Specimen shows white lobulated tumour at upper end of humerus arising in bone affected by Paget's disease. Microscopic examination showed chondrosarcoma.

Case 2

R.C., male, aged 50. Admitted to Royal Prince Alfred Hospital on the 4th July, 1956, under Mr. A. W. Watts, with history of previous fall on shoulder. Had a swelling of shoulder and later developed lumps in skull and sternum. X-rays showed extensive Paget's disease in skeleton. Biopsy revealed areas of sarcoma cells forming bone (osteosarcoma). Serum alkaline phosphatase was 62 King-Armstrong units per 100 cc. Patient died on the 7th November, 1956 (see Figs. I, II, III).

Case 3

M.O., female, aged 66. Admitted to Western Suburbs Hospital on the 10th November, 1947, with a fracture of mid-shaft of left femur; this was plated. X-rays showed advanced Paget's disease in both femora. On the 21st April, 1948, she sustained a pathological fracture of lower right femur. X-rays

	Name	*Hospital*	*Age*	*Sex*	*Site*	*Pathology*	*Treatment*	*Survival*	*Remarks*
1	T.C.	R.P.A.H.	52	F	Femur—upper end		Nil	Few months	Developed at site of transverse fracture with delayed union
2	C.McG.	,,	56	M	Head of humerus	Sclerosing osteogenic sarcoma	Deep X-ray	3 years, 8 months	Secondaries in chest. Skull normal. See X-ray (Fig. IV)
3	E.W.	,,	65	F	Knee		Amputation	Few months	Tumours on skull. Chest X-ray clear
4	E.T.	,,	67	F	Femur—lower end	Osteogenic sarcoma	Amputation	Few months	Secondaries in chest and recurrence in stump and pelvis
5	C.M.	,,	82	F	Ilium		Deep X-ray	4 months	History of fall. Mass in pelvis 15 cm. by 15 cm.
6	W.F.	,,	72	M	Ilium		Deep X-ray	2 months	Pelvic mass 16 cms. diameter
7	S.P.	,,	63	F	Humerus—upper end		Deep X-ray	6 months	Later developed mass in lower end of humerus. Skull normal
8	R.F.	,,	67	M	Acromion	Vascular osteolytic sarcoma	Deep X-ray	6 months	Had fall and pathological fracture of acromion. Tumours in skull—one 3" by 2"
9	O.C.	,,	55	M	Vertebra TV10		Deep X-ray	Not known	Developed paraplegia. X-ray showed erosion of vertebra and generalised Paget's disease in spine
10	R.C.	,,	50	M	Humerus—upper end	Osteogenic sarcoma	Deep X-ray	4 months	Had fall on shoulder. Tumours in skull. See Figs. I, II, III
11	T.M.	,,	62	M	Scapula		Deep X-ray	Not known	Huge mass arising in axillary border of scapula. First noticed after fall. Paget's disease widespread
12	H.H.	R.N.S.H.	73	M	Ilium		Deep X-ray	3 months	Large mass in iliac fossa. X-rays showed Paget's disease in pelvis but not in skull
13	F.B.	Sydney Hospital	60	M	Tibia	Osteogenic sarcoma	Amputation	15 months	Secondaries in stump at mid-thigh
14	R.P.	,,	72	M	Tibia	Osteogenic sarcoma	Amputation	1 year	Secondaries in chest
15	N.M.	,,	75	M	Humerus—lower end		Deep X-ray	3 months	Sarcoma near elbow but whole humerus affected by Paget's disease
16	R.M.	,,	61	M	Skull		Deep X-ray	Not known	Soft swelling covering most of left parietal region. Later another tumour in skull
17	F.K.	,,	64	F	Pelvis—ilium		Deep X-ray	8 months	Secondaries in lungs
18	H.G.	R.N.S.H.	64	M	Tibia		Amputation	1 year	Followed injury. Later developed subtrochanteric fracture in stump of femur
19	W.L.		73	M	Acromion	Osteogenic sarcoma	Nil	2 months	Secondaries in lungs
20	I.S.		69	F	Tibia	Osteogenic sarcoma	Amputation	Few months	

20	I.S.		69	F	Tibia	Osteogenic sarcoma	Amputation	Few months		
21	M.O.	Western Suburbs	60	F	Femur—lower end		Deep X-ray		See case report and X-rays (Figs. V and VI)	
22	C.S.	St. Vincents	62	M	Ilium	Fibro-sarcoma	Deep X-ray	Few months	Secondaries in chest	
23	R.F.	Dr. Hugh Smith's case	60	M	Tibia	Osteogenic sarcoma	Amputation	12 months		
24	K.N.	R.P.A.H.	70	F	Humerus—upper end	Chondro-sarcoma	Amputation	12 months	See case report and Fig. VII	
25	A.C.	Sydney Hospital	53	M	Femur—middle third	Osteogenic sarcoma	Deep X-ray	4 months	See case report	
26	A.R.	"	62	M	Lumbar spine	Osteogenic sarcoma	Nil	2 months	Secondaries in lungs	
27	F.A.	"	66	F	Femur—lower end	Osteogenic sarcoma	Nil	2 months	Tumours also in skull, spine and ribs	
28	M.A.	"	69	F	Femur—lower end	Osteogenic sarcoma	Nil	2 months	Secondaries in spine and lungs	
29	M.U.	R.P.A.H.	67	M	Humerus—upper end		Deep X-ray	3 months	History of injury at work. Developed huge masses arising from skull shortly before death (Fig. VIII)	

showed marked erosion of the shaft at this level and a soft tissue oval swelling in the popliteal fossa (see Fig. V). It was considered to be undoubtedly sarcomatous and she was referred to Royal Prince Alfred Hospital for deep X-ray therapy without a biopsy. Later films showed some sclerosis at the site of the fracture and gradual disappearance of the soft tissue swelling (see Fig. VI). She remained confined to a wheel chair, but was free from pain and lived till January, 1956, nearly eight years after sustaining the pathological fracture.

The absence of a biopsy in this case leaves the exact diagnosis uncertain. However, X-ray signs of a soft tissue tumour associated with bone necrosis both of which were present at the time of the initial fracture, indicated a neoplasm arising at this site which proved to be sensitive to irradiation.

FIG. VIII. Case 29. X-ray of humerus showing sarcoma arising in bone affected by Paget's disease. This case also developed very large swellings in the skull.

Case 4

K.N., female, aged 70. She was first admitted to Hornsby Hospital and then transferred to Royal Prince Alfred Hospital on the 4th January, 1953. Her shoulder had been painful for four months. X-rays revealed a sarcoma arising in the head of the humerus and a biopsy proved to be chondrosarcoma. A forequarter amputation was carried out, but she still suffered intolerable pain and lived only a few months. The specimen showed a well circumscribed mass with a white lobulated appearance (see

Fig. VII). It was invading bone affected by Paget's disease and the upper 20 cms. of the humerus was also thickened and altered by osteitis deformans. There was no evidence of Paget's disease in other parts of the skeleton as shown by X-ray examination. This was the only case of chondrosarcoma noted in the Sydney series.

Case 5

A.C., male, aged 53. Mr. Keith Daymond's case. Admitted to Sydney Hospital in August, 1958. For three years he had noted pain in right thigh and slight bowing of this leg. Pain increased shortly before his admission and he was sent for X-ray examination. While on the X-ray table he had a sudden exacerbation of pain and films showed a recent crack fracture through a large area of bone destruction in the middle third of the femur. The remainder of the shaft of the femur showed several incomplete fissure fractures. He developed a large soft tissue swelling in the thigh and later multiple secondary deposits in his lungs. He died four months after the onset of the pathological fracture.

SUMMARY

Although Paget's disease of bone is very common in the general population of New South Wales, sarcoma arising in bone affected by osteitis deformans is very rare and is considered to be less than 1 per cent.

Twenty-nine cases of sarcoma of this type were found in the records of the four teaching hospitals in Sydney during the last ten years. Included in this series are 5 personal cases which are reported in more detail.

The commonest site of the primary malignant lesion was in the shoulder girdle (9 cases), a part of the skeleton not usually affected by Paget's disease in its early stages. Another striking feature was the development of multiple sarcomatous changes in bone and in six cases in this series these were noted in the skull.

Although several patients developed sarcoma after a definite history of injury and some were associated with fractures when first noted, it was not considered that there was sufficient evidence to indicate the effect of trauma in determining a malignant change. It was noted that only one case of sarcoma developed after a subtrochanteric fracture, the commonest site for fractures in patients with Paget's disease, and no case developed after surgical intervention.

In most cases where a biopsy or autopsy was made the tumour was described as an osteogenic sarcoma, but cases of fibrosarcoma and chondrosarcoma were also found in this series. Amputation of the lower limb was carried out in 7 patients and one forequarter amputation was performed. Only one of these patients lived more than a year after operation. Deep X-ray was given in 16 cases, but appeared to have no effect and most patients died within a few months. There were two exceptions: a man of 56 years with a sclerosing osteogenic sarcoma of the upper end of the humerus lived three years and eight months, and a woman of 60 years with X-ray evidence of a pathological fracture and a soft tissue tumour lived seven and a half years.

ACKNOWLEDGEMENTS

I am indebted to the General Superintendents of Royal Prince Alfred, Sydney, St. Vincent's and Royal North Shore Hospitals for permission to examine their records, and I am grateful to several colleagues mentioned in the text who have allowed me to see cases under their care.

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STRANGULATED DIAPHRAGMATIC HERNIA*

FIVE CASES TREATED SURGICALLY

By JOHN BORRIE

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DIAPHRAGMATIC herniae may strangulate at the most inconvenient times and places, and because of this, their recognition may fall to the lot of any practitioner, and their surgical correction to the lot of any surgeon. As regards the hernia proper, the principles of its treatment are essentially the same as those governing the commoner strangulated inguinal or femoral herniae. In addition, however, there are the special problems associated with any operation involving the thoracic cavity.

In the past sixteen years, the writer has encountered five strangulated diaphragmatic herniae, one congenital through the left pleuro-peritoneal canal, one congenital through the anterior foramen of Morgagni, two traumatic through the left dome of diaphragm and one through the oesophageal hiatus. The purpose of this paper is briefly to describe each of these five herniae and in the light of that experience to mention their pitfalls and to endeavour to indicate safe and logical methods for their correction. The cases are presented chronologically in order to indicate how one's personal experience and views have been formed.

Case 1. Strangulated traumatic left diaphragmatic hernia

The writer first unexpectedly encountered this emergency at Christmas, 1942, when medical officer to a British prisoner-of-war working party of 760 men near Gleiwitz in Upper Silesia, Germany (Borrie and Foreman, 1948). From the prunes and raisins in the British Red Cross food parcels the men brewed "beer" which was freely consumed on Christmas Day. Alcoholic gastritis quickly followed.

One rifleman, aged 22 years, who had been taken prisoner in France on 26th May, 1940, and had been in good health since, went to bed at midnight apparently well. At 3 a.m. on 26th December he awoke with a severe epigastric griping pain radiating upwards behind the sternum. Shortly afterwards he started to vomit, at first stomach contents, later a brown fluid and became breathless. As the symptoms increased in severity, he became excessively thirsty. Because many of his mates had acute Christmas gastritis, his illness was not reported to the Camp Hospital until 10 a.m., some seven hours after its onset.

On examination his face and limbs were cyanosed, he had short gasping respirations at 50 per minute, a temperature of 101.2°F, and a weak, irregular pulse rate of 120 per minute. To ease his distress he insisted on lying on his left side; he was too breathless to give a coherent history.

Abdominal examination showed an acutely tender, flat, rigid epigastrium without bowel sounds. There was no distension. In the chest the trachea was displaced to the right sternal border. The maximal heart impulse was in the right fifth intercostal space 9 cm. from the mid-sternal line; his heart sounds were feeble, fading and irregular. Chest expansion was limited on the left, with a palpable inspiratory and expiratory fremitus, alternating areas of dullness and hyper-resonance, bronchial breathing, and whispering pectoriloquy, but no egophony. At first sight his appearance suggested a perforated duodenal ulcer, though the chest signs suggested pneumonia.

Following an injection of morphine gr. ¼ his vomiting ceased and his pain lessened in severity. After left pleural aspiration of 500 ml. of turbid odourless blood-stained fluid, the respiration rate fell to 40 per minute.

The possibility of a perforated oesophagus or a diaphragmatic hernia was also considered, but it was felt that only chest radiographs and an oesophragm could clarify the diagnosis. Suffice it to say that he clearly had both abdominal symptoms and thoracic signs together with intestinal obstruction and that this triad should have suggested "strangulated diaphragmatic hernia."

Early that afternoon he was transferred to the area Central Prisoner-of-War Hospital at Cosel, Upper Silesia. That evening the same clinical findings were confirmed by the physician in charge, Dr. H. M. Foreman. In addition, a one inch long firmly healed linear scar was noticed between the left 8th and 9th ribs in the anterior axillary line. When questioned, the patient admitted having had a shrapnel wound in that area when captured in 1940, and that he had been treated in a prisoner-of-war hospital for three months with dressings. No opera-

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tion had been performed and radiography had revealed no foreign body. A tentative diagnosis of left hydropneumothorax from perforation of an oesophageal ulcer, or damage from an undiagnosed shrapnel fragment was considered and further thoracentesis performed. This time, however, some 60 mls. of faeculent fluid was withdrawn, establishing the diagnosis of strangulated diaphragmatic hernia.

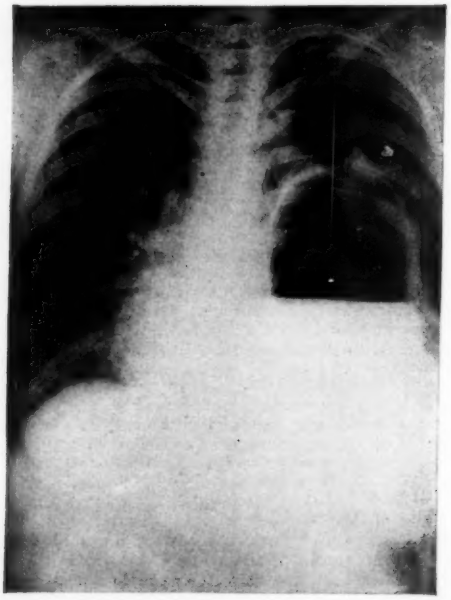


FIG. I. Chest radiograph of strangulated hiatal hernia developing in a pregnant woman at term (Borrie, J., 1958, "Emergencies in Thoracic Surgery," page 301, courtesy Appleton-Century-Crofts).

The following morning, 27th December, 1942, the patient was transferred to St. Carolustift German Military Hospital in Cosel, where radiography confirmed the diagnosis. Operation was performed by Stabsarzt Feiger, with Major Stanley Sykes, R.A.M.C., giving the open ether anaesthesia (the only one available). A midline upper abdominal incision was made and extended to the left at right angles from the umbilicus. Anteriorly in the tendinous dome of the diaphragm was a hole 1½" in diameter through which gut had herniated. The opening was enlarged with a lateral cut and a third of the small bowel was withdrawn, congested but viable. Parts of the transverse colon followed, but pleural adhesions had to be manually broken down before all was free. Thereafter 45 cm. of frankly gangrenous colon and great omentum was removed from the chest. Throughout the operation there was a large sucking pneumothorax through the diaphragmatic opening, and some one and half hours after the operation began, the patient died.

Following autopsy, it was concluded that the shrapnel splinter of 1940 had torn the tendinous dome of the left diaphragm, that at some later date small and large bowel plus great omentum had herniated into the left pleural cavity, and that following acute gastritis of Christmas Day, it had strangulated.

Comment

Regarding diagnosis, this patient shows how important it is to have the lesion in mind and thereby quickly appreciate the significance of both unusual thoracic signs and those of intestinal obstruction. With most of the bowel in the chest cavity, any abdominal distension was virtually impossible. Distension of the herniated bowel in the thoracic cavity, however, accounts for the cardiac displacement, compression of the lung, and grave interference with lung function which in Case 2 proved fatal.

The unfortunate onset of strangulation in a prisoner-of-war in a place and time of the year that made it difficult to get a prompt chest X-ray film, mitigated against early diagnosis and the fact that at that time in Germany modern methods of controlled anaesthesia with cuffed endotracheal tubes and gas and oxygen machines were just not available made any surgical attempt on such a lesion hazardous in the extreme.

Case 2. Strangulated hiatal hernia

Mrs. S.H., aged 30, was admitted to Cornwall Hospital, Auckland, on 11th December, 1951, complaining of abdominal pain and nausea. She was pregnant and one week from term. An admission X-ray film showed a large diaphragmatic hernia completely filling the left pleural cavity. The stomach was grossly distended with fluid and air and the trachea and heart displaced to the right of the midline. A chest X-ray film taken eighteen months earlier was normal. A diagnosis of strangulated diaphragmatic hernia was made (Fig. I).

Operation (13th December — Mr. T. Plunkett and Mr. R. Nicks): Caesarean section was first performed and the child delivered dead. The abdominal incision was enlarged to the xiphisternum and the hernia found passing through a large hole in the back of the diaphragm. Even after incising the hernial ring the hernia could not be reduced. Some fluid and air, however, could be expressed from above downward. Thereafter, with gentle traction for ten minutes the hernia was reduced and found to contain cyanotic but viable stomach, large bowel and small bowel, all of which quickly returned to normal colour. After reduction from the chest, the abdominal contents were packed away, the diaphragmatic opening visualized and found to lie through the oesophageal hiatal region. The opening was closed with interrupted silk sutures. An intercostal water seal drain was inserted into the left pleural cavity, and the abdomen closed with silk sutures.

The writer took over the post-operative care. Post-operative ileus was treated by gastric suction and intravenous fluids for the following week. The patient's left lung completely re-expanded and she made a satisfactory recovery. Seen two months later she was well, and a check barium meal showed no recurrence of the hernia. Seven years after she remains well.

Comment

Again, the inconvenience of strangulating when the patient is nine months pregnant is obvious.

The terminating of her pregnancy by Caesarean section and repairing the hernia through an extended abdominal incision allowed two problems to be corrected by the one approach.

Reduction of the contents was difficult and might have been aided by inserting a Timon's catheter through the hernial ring and alongside the hernial contents, in order to drain fluid and equalize pressure during reduction. Had this not been possible, then a lateral cut from the hernial ring across the dome of the diaphragm, and if necessary incising the left costal margin to create a thoraco-abdominal incision, would have been required. In this case there were no intrathoracic adhesions. Closure of the left plueral cavity over water seal drainage ensured full re-expansion of the left lung.

As this case illustrates, any succesful reduction may be followed by a period of paralytic ileus requiring treatment along usual lines.

Case 3. Strangulated congenital hernia through the left pleuro-peritoneal canal

D.P., a Maori girl aged 12, was admitted under the writer's care to Green Lane Hospital, Auckland, in the early hours of Easter Sunday, 13th April, 1952. She had been at an Easter Holiday Camp, and on the morning of Good Friday, 11th April, had developed upper left abdominal pain and vomiting that had increased in severity. Late on Saturday evening she had been taken to the Waikato General Hospital, Hamilton, where radiographs revealed a strangulated diaphragmatic hernia, and she was immediately transferred 80 miles to Auckland for surgical treatment.

Her past history disclosed that in 1942, when she was 2 years old, a left congenital diaphragmatic hernia had been discovered; but surgical treatment at that time had been refused.

On admission she was in great respiratory distress, with trachea and heart displaced well to the right. Her abdomen showed some rigidity and was not distended. Chest X-ray films at once confirmed that the 1942 appearance of a typical congenital diaphragmatic hernia containing stomach and coils of small and large intestine had now materially altered. There was now gross mediastinal shift to the right, collapse of the left lung, a greatly distended stomach occupying the lower half of the left hemithorax and surrounded by opaque soft tissue shadowing (Fig. II).

The patient was prepared for immediate operation, a stomach tube passed and brown gastric contents withdrawn.

FIG. II. Chest X-ray film showing a grossly distended stomach in the left pleural cavity, mediastinal shift to the right and collapse of the left lung (Borrie, J., 1958, "Emergencies in Thoracic Surgery," page 300, courtesy Appleton-Century-Crofts).

Operation: Anaesthesia was induced in the operating theatre using thiopentone. During endotracheal intubation the heart stopped beating and cardiac resuscitation was imperative.

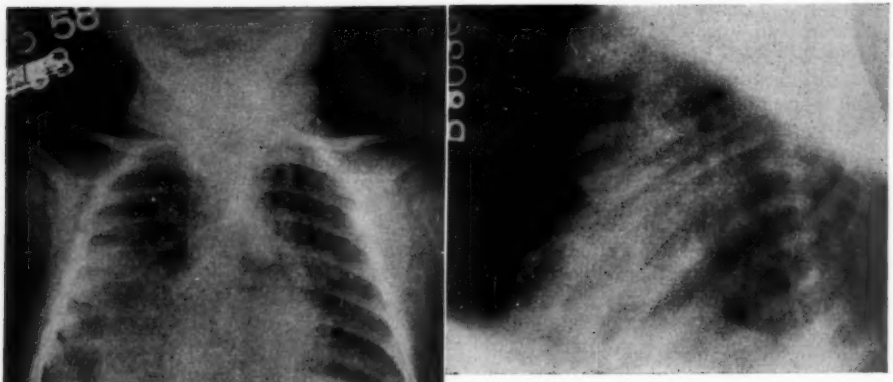
Because of the left-sided strangulated diaphragmatic hernia, a left thoracotomy for cardiac massage was out of the question, and a midline epigastric incision was made. One ml. of 1/1000 adrenaline hydrochloride was injected into the heart and effective cardiac compression obtained between diaphragm and sternum, with immediate return of a forceful heart beat. The total time between recognition of cardiac arrest and the commencement of cardiac compression was three minutes.

The edges of the abdominal incision were loosely approximated, covered with a dressing, the patient turned on her right side, and left thoracotomy performed through the left 8th rib bed.

After aspirating free fluid, inspection confirmed strangulation of the stomach, spleen, greater and lesser omenta, the small bowel and greater part of the large bowel, all of which were dark blue in colour. Adhesions were divided and the neck of the hernia in the dome of the diaphragm sought and enlarged by a lateral incision, with prompt recovery of the bowel.

The spleen, stomach, large bowel, omenta and finally the small bowel were then reduced in turn and without difficulty. The hernial edges were easily approximated in two layers with No. 4 silk sutures, and the thoracotomy and abdominal incisions closed in layers. The patient, however, was slow to regain spontaneous respiration, she remained in coma and died as the result of cerebral anoxia from her episode of cardiac arrest eight hours after operation.

The episode of cardiac arrest during induction of anaesthesia was considered to be due to the fact that at rest, with grossly distended strangulated bowel in the left chest, the child's ventilation was barely adequate when she was conscious. With the onset of anaesthesia, which involved an arm injection, oxygenation and laryngoscopy as a prelude to intubation, the release of voluntary control of the respiratory muscles allowed the intrathoracic tension of the strangulated hernia to exert its full effect and collapse the remaining right lung, with resulting acute anoxia and cardiac arrest.



(a) (b)

FIG. III (a) and (b). Chest radiograph showing a large air containing sac apparently surrounding the heart. Right, a lateral film showing that the air lay in front of the heart, and confirming the diagnosis of strangulated anterior diaphragmatic hernia. Note the prominent sternum.

Comment

This patient, like the first, illustrates the inconvenient time and place that such herniae may choose to strangulate, for she was far from any medical aid, and the significance of her early symptoms not clearly appreciated by those in charge of the Easter Camp.

The abdominal approach for cardiac resuscitation was deliberately chosen as being the only quick, unencumbered route to the heart; and, as a means of obtaining effective manual compression as quickly as possible, the choice was justified. Nevertheless, in this child the three minute time lapse between recognition of cardiac arrest and effective cardiac compression was just too long, with the inevitable result. The transthoracic approach for relief of the strangulation made for easy division of adhesions and reduction and repair of the hernia.

It finally illustrates the utter fallacy and great danger of leaving untreated these congenital herniae, which when not strangulated

are readily correctable, but when strangulated, though also correctable, are fraught with additional, unforeseen dangers.

Case 4. Strangulated congenital anterior diaphragmatic hernia

W.G., a baby girl aged 9 months, was admitted as an emergency to Wakari General Hospital, Dunedin, on Sunday, 18th May, 1958.

Over the preceding week she had been off colour, and had developed a severe cough, and was feverish and listless. For four days she had been vomiting and had been unable to retain any nourishment.

Her temperature was 100.2°F, the apex beat of 130 per minute, and the respiration rate 60 per minute. She was listless and dehydrated, with a dry skin and depressed frontanelles.

The striking physical finding was a very obvious bulging forwards of the precordium which was hyperresonant to percussion. In addition there were moist sounds audible over the chest posteriorly, especially at the base of the left lung. The tongue was dry and the abdomen soft and not distended. Borborygmi were audible. The heart was clinically normal.

The admission diagnosis had been "pneumonia," but a postero-anterior chest X-ray film showed a large air-containing "cyst" completely surrounding the heart and resembling a pneumo-pericardium. Lateral films, however, revealed that this air-containing sac lay immediately behind the sternum in the anterior mediastinum and that it displaced the heart backwards (Figs. III [a] and [b]).

The diagnosis of strangulated anterior diaphragmatic hernia was therefore made, and in view of the dehydration intravenous therapy was commenced. Because of the obvious bronchitis she was given chloromycetin.

Operation: This was performed that same evening. Anaesthesia was induced with open ether and the patient intubated and connected to an Ayre's T-piece. The operative approach was debated and finally the upper abdominal route chosen. The abdominal cavity was opened through a midline incision stretching from the xiphoid process to the umbilicus. A distended loop of transverse colon was found entering through the diaphragm into the anterior mediastinum (Fig. IV). The efferent loop was not dilated. The bowel was reduced by gentle traction, accompanied by gurgling and an obvious sucking noise. The obstructed loop immediately regained its normal colour. Inspection showed that the sac also contained the left lobe of liver which was reduced by passing an index finger above the liver and hooking it down. Inspection showed that the sac extended up as far as the sternal angle, and laterally to the rib ends on either side. It did not communicate with any of the three intrathoracic serous cavities (Fig. V).

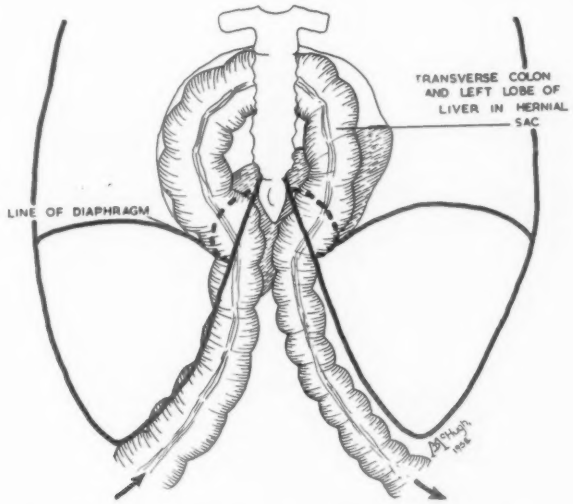


FIG. IV. Diagram of findings at operation with transverse colon and the left lobe of liver in the sac.

The neck of the sac was formed in front by the xiphoid process, on either side of the costal margin, and behind by a crescentic anterior free edge of diaphragm stretching between the right and left 8th costal cartilages. This crescentic rim of diaphragm was first approximated in the midline by four double No. 4 silk sutures, and thereafter the free edge was sewn in the midline to the xiphoid process of the sternum, and on either side to the costal margins by six interrupted double No. 4 silk sutures — there

being three per side. The suturing, by anchoring the diaphragm to its usual attachment, completely closed off the hernial sac from the peritoneal cavity (Fig. VI). The abdomen was closed in layers by the standard technique. Immediate post-operative chest radiography confirmed there was no air in the pleural cavities, but that the hernial sac still contained air.

Post-operative course: On the day after operation a radiograph confirmed acute dilatation of the stomach. A stomach tube was passed, and gas and brown faeculent fluid withdrawn.

was discharged eighteen days after admission. A year later she is fit and thriving, and her chest radiographs are satisfactory.

Case 5. Strangulated traumatic left diaphragmatic hernia

J.B., a man aged 54, was admitted as an emergency to Wakari General Hospital on 2nd September, 1958, at 6.45 p.m. with a history that he had been knocked down by a car and dragged 60 feet three days before (30th August). He had reported to Casualty Department, but apart from a severe bruise

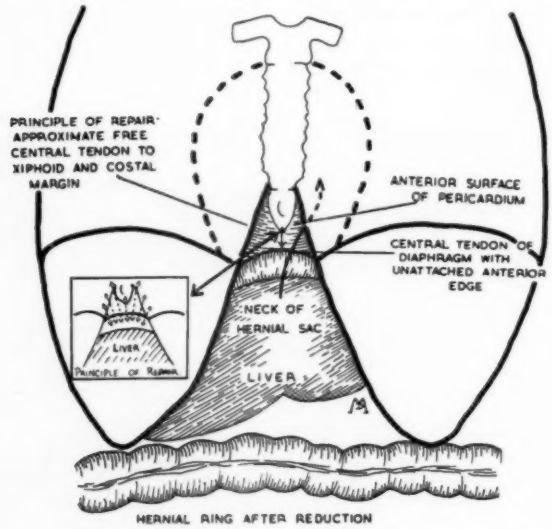

PRINCIPLE OF REPAIR
APPROXIMATE FREE CENTRAL TENDON TO XIPHOID AND COSTAL MARGIN
ANTERIOR SURFACE OF PERICARDIUM
CENTRAL TENDON OF DIAPHRAGM WITH UNATTACHED ANTERIOR EDGE
NECK OF HERNIAL SAC
LIVER
HERNIAL RING AFTER REDUCTION

FIG. V. Sac after reduction of hernia showing the neck formed by the xiphoid, anterior costal margin and the unattached anterior margin of the diaphragm.

On the second post-operative day the babe had greatly improved, gastric aspirations were almost nil and bowel sounds audible. There was an excellent result from passage of a flatus tube. Her antibiotic was changed to erythromycin.

The intravenous therapy was as follows:—

Day of admission, 150 ml. blood and 450 ml. normal saline.

On the first post-operative day, 200 ml. M/6 lactate, 50 ml. 1/5 normal saline, 750 ml. ¼ normal saline + KCl and 200 ml. 1/5 normal saline.

On the second post-operative day, 300 ml. 1/5 normal saline, 550 ml. ¼ normal saline + KCl and 50 ml. 1/5 normal saline.

As a result of general improvement the intravenous drip was removed and the child took oral feeds avidly.

A week after operation the sutures were removed. Chest radiographs showed slow but satisfactory resolution of a left lower lobar pneumonia and she

in the left loin, no serious disorder was detected and no radiographs were taken. He went home, but on 31st August developed a severe chest pain, left shoulder pain and vomiting, which had shown no signs of abating. His admission diagnosis had been traumatic haemothorax. On examination there were physical signs of fluid in the left chest together with cardiac displacement to the right. Chest X-ray films confirmed a strangulated diaphragmatic hernia which displaced the mediastinum to the right (Fig. VII).

Operation (2nd September): At 8 p.m. a Ryle tube was passed, and after some difficulty was made to enter the stomach. One pint of brown fluid together with gas was aspirated from the stomach.

Anaesthesia was next induced and a left 8th intercostal space thoracotomy performed. An enormously dilated stomach plus a loop of transverse colon lay in the left pleural cavity. Over 100 ml. of pleural fluid were removed. The tight hernial ring was incised two inches laterally and thereafter the contents were reduced to the abdominal cavity.

Inspection showed that there had been a radial split of the left leaf of diaphragm from the region of the hiatus forwards and to the left across the tendinous part of the dome of the diaphragm. The defect was closed with two layers of double No. 4 interrupted silk sutures. The lung was inflated and the chest wall closed over water seal drains, using interrupted catgut for all deep layers and nylon for the skin.

In the pre-operative phase a stomach tube could fortunately be negotiated into the stomach which was thus decompressed before operating, thereby both avoiding the hazards of cardiac arrest during induction of anaesthesia, and also increasing the ease of surgical correction.

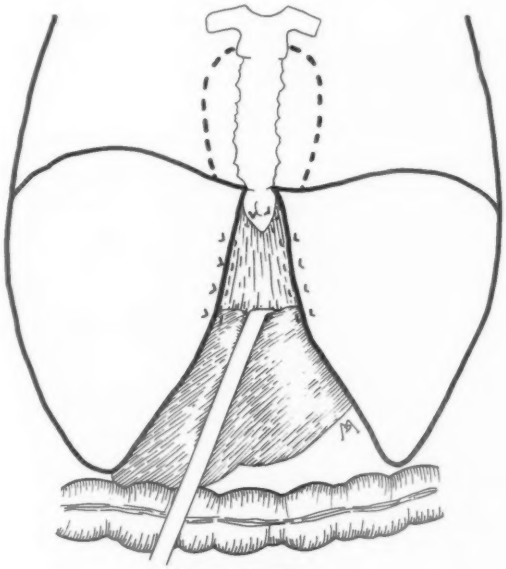


FIG. VI. Technique of closure of the sac by attaching the diaphragm to the costal margin and xiphoid process.

At the time of reduction a wide bore stomach tube was temporarily inserted down the oesophagus to drain off any residual gastric fluid.

The patient was treated with repeated gastric aspirations for thirty-six hours with supportive intravenous therapy. Thereafter, as his bowels had moved, fluids were taken by mouth. He was discharged fit on 29th September, twenty-seven days after operation, and remains well and working eight months after operation. An associated impacted fracture of the left pubic bone was merely treated by rest.

Comment

The sudden trauma ruptured the diaphragm, and yet, had the Casualty Officer who first saw him X-rayed his chest, the chances are that no hernia would have then been detected. With subsequent straining stomach and bowel would appear to have entered the pleural cavity and strangulated.

It again emphasizes the not so obvious sequelae of severe body trauma, and the need for keeping such patients under review after such an accident.

DISCUSSION

Pathology and the significance of clinical features

These case reports cover the usual range of strangulated diaphragmatic herniae and illustrate that the strangulating hernia may be congenital or acquired in origin.

The *congenital* herniae occur most commonly through the pleuro-peritoneal canals, being five times as common an the left as on the right side (Gross, 1953). Much rarer sites are anteriorly through the foramen of Morgagni, posteriorly through the oesophageal hiatus, or behind the aortic hiatus.

The *acquired* herniae are almost always traumatic in origin, rarely hiatal or from necrosis and usually through the left dome of the diaphragm. They should always be regarded as requiring correction without delay because of their great tendency to strangulate, for 90 per cent. of strangulated diaphragmatic herniae are traumatic in origin (Carter and Giuseffi, 1948).

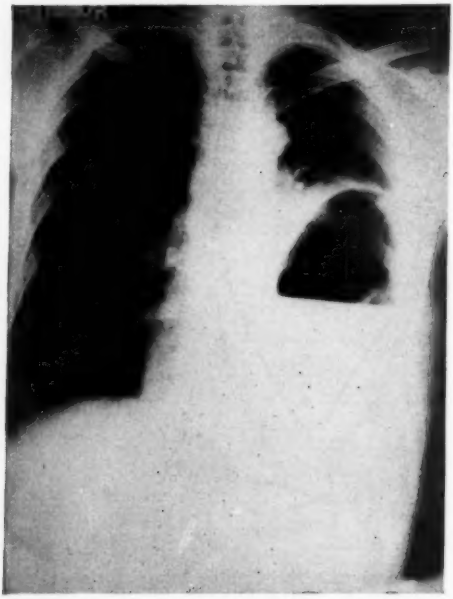


FIG. VII. Chest radiograph confirming strangulated left diaphragmatic hernia.

Age offers no security, for these herniae have strangulated in babies as young as 2 weeks or in adults up to 75 years old (Borrie, 1958). In this series the ages were 9 months, 11, 22, 30 and 54 years respectively).

The neck of a strangulated diaphragmatic hernia varies according to site and may be a tear passing forwards across the central tendon of the diaphgram from the region of the oesophageal hiatus, as in a traumatic hernia, a congenital opening in the posterolateral portion of the diaphragm, an opening in relation to the hiatal ring as occurs with a para-oesophageal hernia, and rarely the anterior costal margin and free edge of the diaphragm in an anterior hernia.

Though small and large bowel may strangulate more readily than the stomach, this is clearly not immune, nor is strangulation confined to the left side only. Once strangulation has occurred, there is progressive distension of the gut, not in the abdomen, but in the chest cavity. The result is that not only are the *primary* effects of strangulation apparent with agonizing pain, severe vomiting and constipation, but in addition the *secondary* effects of the distending bowel seriously interfere with the mechanisms of breathing and venous return to the heart, resulting in acute dyspnoea. Thus the typical triad is agonizing griping epigastric pain radiating up behind the sternum, severe dyspnoea, and vomiting that rapidly become faeculent. The full significance of this was painfully clear in Case 2 where a leisurely intubation allowed the full distension pressure to exert its force just long enough to cause acute anoxia, temporary heart arrest, and ultimate death.

Because of the hernial contents in the left pleural cavity the approach for cardiac compression had to be abdominal and an effective heart beat was quickly restored by this route. Recognition of the cardiac arrest just a few seconds earlier could have tipped the balance in favour of the patient.

The physical signs are again dependent on the mechanism of the strangulation. Strangulated traumatic, hiatal and congenital posterolateral herniae all have similar signs. With the distension all in the chest cavity, abdominal distension characteristic of other strangulations is usually absent. The trachea and apex beat are grossly displaced, usually to the right, there is a rapid pulse, at times irregular and alternating areas of dullness, hyper-resonance, bronchial breathing and whispering pectoriloquy.

Strangulated anterior herniae, especially in the young produce a typical ballooning forwards of the sternum, and hyperresonance over this area due to the subjacent distension of the coils of bowel. Depending on the site of intestinal obstruction, so once again abdominal distension will be absent, or if present of little significance compared to the intrathoracic distension.

Diagnosis

Not only do chest films provide a sure short cut to correct diagnosis, but they also indicate the degree of mediastinal displacement and respiratory embarrassment.

With a posterolateral hernia, congenital or acquired, films may show an enormous stomach that may simulate a high diaphragm, or alternatively areas of opacity from pleural fluid and translucency from distended stomach or coils of bowel all collapsing a lung, usually the left, and displacing the heart (see Figs. I and II).

With an anterior hernia a postero-anterior film will reveal an air-containing cyst apparently completely surrounding the heart and resembling a pneumo-pericardium. Lateral films, however, solve the riddle and show that this is due to distended bowel lying between the sternum and the pericardium and displacing the heart backwards as occurs with a strangulated anterior diaphragmatic hernia (see Figs. III [a] and [b]).

Mortality

Delay in diagnosis still keeps the mortality high. Prior to 1920 it was over 88.8 per cent. with an operative mortality of 66 per cent. In the period 1920 to 1945, Carter and Giuseffi (1948) found an over-all mortality of 57.1 per cent. and an operative mortality of 43.7 per cent. Two of the five patients reported here have died.

TREATMENT

For all cases immediate surgical relief is imperative. The approach varies with the site.

(A) *Strangulated traumatic and postero-lateral herniae*

Because of the strong possibility of adhesion between bowel, lung, pleura and pericardium, a lateral thoracotomy that can be extended across the anterior costal margin on to the abdominal wall is advised and preferably through the 7th intercostal space or 8th rib bed.

Pre-operative preparation

The aim should be to decompress the stomach of gas and fluid by passing a transnasal Levine tube. An enema may be given and an intravenous drip set up to replace fluids lost by vomiting. Blood samples are taken for electrolyte measurement. Blood is also cross-matched for transfusion. Pre-operative sedatives such as morphine lessen the patient's obvious distress.

Anaesthesia

The second case report shows how careful induction must be, especially if the pre-operative decompression of the bowel has not been complete. Anaesthesia must be light, intubation quickly performed and the patient put on controlled positive pressure anaesthesia from the start, so avoiding any tension effects from the distended bowel on pulmonary ventilation.

The operation

The principles of the operative procedure in no way differ from strangulated inguinal or femoral herniae.

Immediately the pleural cavity is opened, the free fluid is sucked away, the constricting neck of the hernia found and incised laterally giving immediate relief. The anaesthetist aspirates the Levine tube, or if there is gross gastric dilatation, inserts a wide-bore stomach tube. He also reinflates the lung.

Adhesions between bowel and the lung are next divided; and if the circulation of the bowel is satisfactory, it is reduced to the abdominal cavity. The defect in the diaphragm is then closed, preferably in two layers with interrupted silk sutures, and the chest wall closed over water seal drainage. If the bowel is necrosed it is resected along standard lines, this being facilitated by a thoraco-abdominal extension of the incision.

(B) *Strangulated anterior herniae*

These are essentially congenital in type and usually without adhesions.

Approach

In general, as these herniae are either midline or just to one side, a midline epigastric incision gives good access. When lying to one side but with contents extending well into the pleural cavity, then an anterior intercostal thoracotomy that allows division of the costal margin, can also be considered.

Pre-operative preparation

This follows along the lines already described. In vomiting babies, subcutaneous fluid may be required as well as intravenous therapy.

Operation

A midline epigastric incision is made, and the abdominal cavity opened to disclose bowel entering through the hernial ring. This ring is then incised laterally, using a hernia director if indicated. Any fluid is aspirated, and a catheter inserted into the sac alongside the bowel in order to equalize pressures. Thereafter the hernial contents are reduced, using gentle traction for any bowel or omentum, and finally hooking down any liver with an index finger.

The sac is inspected. If either pleural cavity has been entered an intercostal water seal drain is inserted through a lateral stab-drain. The neck of the sac is next closed by re-attaching the diaphragm to its normal position along the anterior costochondral margin and xiphoid process, using a series of interrupted silk sutures. In Case 4 it was certainly convenient first to attach the centre of the anterior diaphragmatic edge to the xiphoid process before the lateral sutures were placed. If no intercostal drain was inserted, then, before the final costophrenic suture is placed, a catheter is slipped into the hernial sac, all air is aspirated while the anaesthetist inflates the lungs, and the catheter removed as the final suture is tied. The abdomen is closed by standard methods.

Post-operative care

Chest radiographs check total lung expansion, and the intercostal drainage tube is removed after twenty-four hours. The gastric tube, which remains *in situ* as a safeguard against the onset of paralytic ileus or acute dilatation of the stomach, is aspirated hourly. Intravenous therapy is continued and accurate fluid balance charts and electrolyte estimations maintained until bowel sounds are normal and flatus passed. Prophylactic antibiotics are given especially in the presence of any respiratory infection.

Summary and Conclusions

Five cases of strangulated diaphragmatic hernia, two traumatic, one hiatal, one congenital posterolateral and one congenital anterior, are described and the plan of management outlined. It is concluded that the essentials in successful treatment of strangulated hernia are these:—

(1) Have the lesion in mind, especially in the young and after accidents.

(2) Beware of the triad of intestinal obstruction producing abdominal symptoms of pain and vomiting, together with thoracic signs of severe dyspnoea — cardiac displacement and alternating areas of dullness and hyperresonance in one of the lung fields.

(3) Take X-ray films of the chest to establish diagnosis and doubt a report of "raised diaphragm" for it is more likely a diaphragmatic hernia.

(4) As soon as the diagnosis is made, decompress the stomach by oral intubation and suction.

(5) Beware of cardiac arrest during induction of anaesthesia, especially if the stomach has not been decompressed.

(6) Explore and divide the neck of the sac, reduce the hernia and repair the defect. A posterolateral thoracotomy is ideal for all posterolateral herniae, congenital, traumatic or hiatal. A mid-epigastric incision is favoured for strangulated anterior hernia.

(7) Beware of and treat any post-operative ileus.

Acknowledgements

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FATAL POST-OPERATIVE PANCREATITIS

By E. S. R. Hughes and G. A. Kune

Royal Melbourne Hospital

FATAL pancreatitis following operation has attracted attention in the last few years. For example, Frieden (1956) reported 22 cases from the Los Angeles County Hospital; Ferris, Lynn and Cain (1957) nine cases from the Mayo Clinic; whilst Thompson, Howard and Vowles (1957) of Atlanta, Georgia, added four more cases and reviewed the literature.

Three additional cases are reported here. All occurred within a relatively short period of time in one surgical unit of the Royal Melbourne Hospital.

Case Reports

Case 1

Mr. H.S. (R.M.H. 179074), in 1943, at the age of 43 years, developed attacks of stabbing pain in the upper abdomen which passed through to the back and up under both shoulder blades. These attacks lasted up to four hours and recurred at frequent intervals, at times, daily. They were accompanied by nausea but not vomiting. The pain was aggravated by lying down and relieved by standing up. In 1952, the pain became more constant and it seemed to him as though there was something causing heavy pressure within the upper abdomen. On several occasions the pain was accompanied by jaundice. In 1953, the gall-bladder was removed at another hospital; apparently it was found filled with pus. In 1954 he had a recurrence of the abdominal pain, accompanied by jaundice, and a second operation was performed. The head of the pancreas was found firm and enlarged; no stones were detected in the common bile duct. Attacks of pain and jaundice continued and in November, 1957, he was admitted to the Royal Melbourne Hospital. His general health was good. His appetite was satisfactory and did not seem affected by the pain. No foodstuffs seemed to precipitate or ease the pain. He usually had two or three bowel actions daily.

Examination showed him to be overweight, with a blood pressure of 175/90 mm. of mercury. He was tender under the right costal margin and in both loins. A barium meal and choledochogram were normal. Whilst in hospital he had an attack of severe abdominal pain and it was decided to perform a laparotomy.

At operation on the 14th November, 1957, the head of the pancreas was found indurated and enlarged. The neck and tail were not affected. The whole pancreas retained its mobility. The common bile duct appeared normal and a probe inserted down the duct passed easily into the duodenum. The duodenum was opened and a probe was passed readily along the pancreatic duct of Wirsung. A sphincterotomy was performed.

He was well on the first post-operative day but thirty-two hours after operation he suddenly collapsed. The pulse rate rose to 140 per minute and the blood pressure fell to an unrecordable level. He was pale, sweating and disorientated. A gastric tube aspirated a small quantity of dark "coffee-grain" material. An intravenous saline transfusion of 500 ml. was followed by 1,500 ml. of blood. His systolic blood pressure rose to 120 mm. of mercury, and the pulse rate fell to 120 per minute. His mental condition became more orderly and at this time he complained of severe central abdominal pain passing through to the back. The urinary diastase was 200 units, the serum amylase 200 units and the serum bilirubin 1.6 mgm. per cent.

In the twenty-four hours after the onset of shock and acute abdominal pain his urinary output fell to 150 ml. The blood pressure was unstable, falling at intervals to 80 mm. of mercury systolic. On the 18th November, the serum amylase was 30 units and the blood urea 147 mgm. per cent. By the next day the blood urea was 208 mgm. per cent. but a subsequent improvement in the urinary output brought the blood urea down to 134 mgm. per cent. on the 22nd November. However his condition remained unsatisfactory and on the 24th November he developed muscle twitching. (Electrolyte estimations at this time showed Na. 152 mEq./l; K. 6.8 mEq./l; Ca. 3.85 mEq./l; Cl. 88 mEq./l; alk. reserve 22 per cent. carbon dioxide.) On the 25th November he had a severe epistaxis and the blood pressure fell sharply. On the 26th November, the blood urea had increased to 480 mgm. per cent. He continued to deteriorate slowly and finally died on the 28th November, fourteen days after operation.

Autopsy revealed the stomach and spleen bound firmly to the surface of the pancreas. On separating the stomach a large abscess cavity was found along the upper border of the pancreas. Two similar cavities were found behind the hepatic and colonic flexures. Section through the pancreas revealed numerous abscess cavities varying from 3 to 20 mm. in diameter. All cavities contained thick yellowish brown material. The fatty tissue around the pancreas showed patches of fat necrosis. Microscopic examination showed necrosis of both acini and islet cells with areas of polymorph accumulation. There was little remaining pancreatic tissue, but that present showed no evidence of fibrosis.

Case 2

Mrs. A.G. (R.M.H. 180428), aged 60 years, was referred on the 1st November, 1957. For twelve months she had suffered attacks of abdominal pain

of relatively mild severity. In October, 1957, she had a very severe episode. The pain came suddenly, was situated under the right costal margin and radiated to the back but not to the shoulder. The pain made her restless and lasted twelve hours. Her urine was dark after the attack and her doctor thought she was jaundiced. The acute pain subsided after an injection of morphia but she remained sore under the right costal margin for several days. Two weeks later she had another attack but of milder severity.

Examination showed her to be of fairly small physique (130 pounds: 58.9 kg.). She was tender under the right costal margin. A cholecystogram showed a non-filling gall-bladder.

On the 9th December, through a Kocher subcostal incision, a thin walled gall-bladder containing numerous small stones was removed. The common bile duct was of normal calibre and no stones were palpated in it but it was opened, explored and drained. No stones were found. The pancreas felt a little thickened but was otherwise regarded as normal.

Following operation her condition was good for thirty-six hours but on the evening of the 6th December she became cold and clammy and complained of weakness and a tightness across the epigastrium. The pulse rate rose to 90 per minute and the blood pressure fell from 140/90 mm. of mercury to 90/70 mm. of mercury. There was diminished air entry at both bases with a few scattered crepitations on the right side. The upper abdomen was a little distended with some tenderness in the epigastrium. The bile duct tube was draining bile freely.

She was treated conservatively and the blood pressure recovered gradually. On the following day she vomited several times and a gastric tube was passed. A total of 700 ml. was aspirated in the first twenty-four hours, 500 ml. in the second twenty-four hours and the tube was then removed. The bile duct tube was removed on the 19th December. Her progress was slow but appeared satisfactory. There was slight epigastric tenderness and a persistent but very moderate upper abdominal distension. She was allowed to go home on the 23rd December to continue her convalescence.

In the first week of January, 1958, she had an attack of diarrhoea and vomiting which recurred two days later. Her temperature was elevated, the abdomen was a little distended and tenderness in the epigastrium had increased. On the 6th January, some pus and bile discharged from the wound and she felt better.

Her condition did not show any sustained improvement and on the 27th January she was admitted to the Royal Melbourne Hospital. Her temperature was 99 degrees F., pulse rate 90 per minute and respirations 20 per minute. There was a purulent discharge from the wound, and a vague tenderness deep to it. Investigations showed that the haemoglobin was 63 per cent., a white blood cell count 10,000, an X-ray of the chest normal, and a culture from the discharging wound grew *Staphylococcus aureus*, gram positive.

Over the next few days her temperature showed a persistent elevation and she remaind uncomfortable in the epigastrium. An intravenous cholecystogram failed to produce a shadow in the common bile duct. A sinugram revealed extensive deep ramifications of the discharging sinus; a communication with the common bile duct was demonstrated.

On the 6th February laparotomy was performed through the original Kocher incision. The head of the pancreas appeared replaced by necrotic material mixed with pus. A large quantity of this was sucked out and a drainage tube inserted. The common bile duct was reopened and a tube inserted. Although the operation was short and easy technically she tolerated it poorly and for the first thirty minutes after operation her respirations remained at 6 per minute and the blood pressure was unrecordable. Her condition improved with nor-adrenaline in saline followed by 500 ml. of blood.

On the 7th February she had improved a little more. The blood sugar was 0.06 per cent. and the urinary diastase 7 units. A culture from the pancreatic abscess revealed *Bacillus coli*. On the 8th February the improvement was maintained but on the 9th February the blood pressure dropped sharply to 90 mm. of mercury and the pulse rate rose to 130 per minute. At this stage she became grossly oedematous with swollen legs and crepitations at both lung bases. Levophed intravenous infusion restored the blood pressure to 125 mm. of mercury. It was maintained at this level for twenty-four hours but on the 11th February she collapsed and died, five days after the laparotomy, and two months after the original operation.

Autopsy examination showed that the head of the pancreas was partially replaced by a mass of fibrous tissue, fibrin and necrotic fat. The body and tail of the pancreas appeared normal. The cavity in the pancreatic head extended into the common bile duct but the pancreatic duct was not identified. Widespread fat necrosis was present.

Case 3

Mrs. I.E.McP. (R.M.H. 181189), aged 61 years, had suffered recurrent bouts of epigastric pain for seven years. The pain passed through to the back and lasted usually for a few days. She had not observed jaundice and had not noticed her urine a dark colour. Her general health was good.

She was overweight, with a blood pressure of 180/90 mm. of mercury. A cholecystogram showed a functioning gall-bladder containing stones.

On the 13th March, 1958, a cholecystectomy was performed. The common bile duct and pancreas felt normal and were not explored. The operation was uneventful as was the immediate post-operative convalescence.

On the 17th March she became lethargic and on the 18th March her temperature rose sharply to 102 degrees F. There was no obvious cause but on the next day the wound felt indurated and it was thought that infection was responsible for her condition. A feeling of malaise and of discomfort in the abdomen persisted, and as the temperature remained elevated the wound was explored on the 23rd March. No pus was found. Despite the minor

nature of the procedure she was distressed after the operation, with a pulse rate of 160 per minute and a respiratory rate of 40. Two hours after operation the blood pressure fell to 95 mm. of mercury where it remained for the next twenty-four hours. On the 25th March she was jaundiced, her urinary output diminished and her mental condition was poor. She died suddenly the same day.

Autopsy showed gross oedema of the retroperitoneal tissue around the pancreas and kidneys. There were numerous areas of fat necrosis. The pancreas itself was considerably enlarged with mottled areas of haemorrhage. Numerous minute abscess cavities were scattered throughout the pancreas. The largest abscess was 1.5 cms. in diameter and situated in relation to the lower end of the common bile duct with which it communicated.

DISCUSSION

In each case of this series the preceding operation was conducted on the biliary tract. In one, the procedure was confined to removal of the gall-bladder. In the other two, the common bile duct was explored and in one of these the choledochotomy was combined with transduodenal sphincterotomy. This preponderance of biliary tract operations preceding the pancreatitis has been emphasized in other reports. A series of 75 cases of acute post-operative pancreatitis collected from the literature were reviewed by Thompson, Howard and Vowles (1957). In 66 of these the preceding operation had been recorded and in 62 the operation entailed exploration of the common bile duct. Nine fatal cases of post-operative pancreatitis from the Mayo Clinic were analyzed by Ferris, Lynn and Cain (1957); three followed biliary tract surgery and one a pancreatic biopsy; one other followed a gastric operation and the remainder more distant procedures. Enquist and Gliedman (1958) studied 85 patients who died of acute pancreatitis; four of these followed operation and in two the operation was performed on the biliary tract. Pollock (1959) investigated 100 cases of acute pancreatitis; three followed operation and in two of these the operation consisted of transduodenal sphincterotomy and pancreatography.

In the three cases reported here the complication appeared shortly after operation. In Case 1, it was thirty-two hours; in Case 2, thirty-six hours; and in Case 3, the first evidence of the complication appeared on the fourth post-operative day. In the Mayo Clinic series the complication appeared within three days of the original operation in each case (Ferris, Lynn and Cain, 1957). In the four cases reported by Thompson, Howard and Vowles (1957) the interval was twelve hours, four days and nine days from the time of the operation respectively.

In this series the presence of the pancreatitis was confirmed on each occasion by autopsy. The pancreas and surrounding tissue was very oedematous, with fat necrosis. Numerous minute areas of haemorrhage were scattered through the pancreatic substance. Cavities of variable size and filled with a semisolid material composed of necrotic tissue and pus were constant features. These were generally small, and in each case there was a cavity in relation to the lower end of the common bile duct. There was no evidence of massive haemorrhage in this series. In the Mayo Clinic series, five showed acute pancreatic necrosis, and three a haemorrhagic necrosis (Ferris, Lynn and Cain, 1957). In Frieden's series there were 14 with necrosis without haemorrhage, seven with haemorrhagic necrosis and one with suppuration and necrosis (Frieden, 1956). It seems, therefore, that the non-haemorrhagic form of pancreatitis predominates.

In two cases in this series the initial clinical features were those of collapse brought about by a peripheral circulatory failure. In Case 1, the collapse was of an alarming nature; in Case 2 it was less pronounced. Following recovery from shock both patients complained of upper abdominal pain. In Case 3, lethargy and upper abdominal discomfort were the initial symptoms, and they did not appear until the fourth day. Jaundice developed early in Case 1, but as a terminal event in the other two. Vomiting was not a feature in these cases. The urinary diastase was elevated in Case 1 but it was not estimated in the other two. The correct diagnosis was made in Case 1, but in Case 2 it was felt that the patient was suffering from basal pneumonia and in Case 3 from a deep wound infection. In this series and in the Mayo Clinic series a considerable fall of blood pressure heralded the onset; upper abdominal pain followed. Renal failure, very prominent in Case 1 and present in the other two, was also a notable feature of the cases reported by Boles (1956) and by Thompson, Howard and Vowles (1957).

In this series Case 1 was treated conservatively. The diagnosis was not considered to

be in doubt, the patient was very ill, and there seemed little that surgery could offer. In Case 2, the abscess cavity in the pancreas was drained and a tube re-inserted into the common bile duct. In Case 3 the operation was confined to exploration of the more superficial parts of the wound. In both patients subjected to operation the blood pressure dropped and the pulse rate rose alarmingly towards the end of the procedure. No satisfactory explanation was found for this complication because the operation itself was not severe, and the anaesthetic was administered by an experienced anaesthetist. It is possible that the adrenal glands are affected by the oedema and that hydrocortisone might help to reduce the severity of this reaction. In their review of the literature, Thompson, Howard and Vowles (1957) found that 10 of 12 patients subjected to operation died; 30 patients were treated conservatively and 20 died.

In the entire collected series of 75 patients studied by Thompson, Howard and Vowles (1957) 58 died (mortality 77 per cent), indicating the serious nature of the complication. Prevention should, therefore, be the objective. Most cases follow exploration of the common bile duct, and for this reason, the surgeon should select cases for this procedure with care. In a series of 22 cases reported by Frieden (1956) 10 had evidence of pre-existing pancreatis. There was reason to believe that Case 1 in the present series had had attacks of pancreatitis in the past. In a non-fatal case of one of the writers (E.S.R.H.), reported by Alan Cuthbertson (1957), a needle pancreatic biopsy was performed; a predisposing hazard also observed by Frieden (1956). In none of the cases in this series was a long armed T-tube inserted into the common bile duct but there have been examples of this manoeuvre being followed by pancreatitis (Thompson, Howard and Vowles, 1957).

The significance of post-operative pancreatitis is threefold. First, it may assume such severe manifestations that it proves fatal despite every effort. Fatal complications following surgery for a benign lesion are especially tragic and require careful study if the necessary prophylactic procedure is to be found. Secondly, the operative mortality following biliary tract surgery is very low and acute pancreatitis appears to be one of the more common causes. It is interesting to observe that the one death in a series of 768 procedures on the extra-hepatic biliary tract reported by Babcock and Eyerly (1957) was caused by acute pancreatitis. Thirdly, non-fatal forms may occur, and may exhibit the tendency of pancreatitis to recur. In doing so the pancreatitis will be responsible for recurrent attacks of post-cholecystectomy pain, perhaps accompanied by jaundice and in which at operation no stone is found.

SUMMARY

1. Three cases of fatal post-operative pancreatitis are presented.
2. In each case the preceding operation was conducted on the biliary tract. In one the operation was confined to removal of the gall-bladder but in the other two the common bile duct was explored.
3. The complication appeared within four days of the operation.
4. The pancreas, at autopsy, showed oedema and fat necrosis but minimal haemorrhage.
5. Circulatory collapse and upper abdominal pain were the initial symptoms in two patients; in the third, the onset was less acute.
6. A second exploratory operation was not well tolerated in the two patients in whom it was conducted.
7. The complication might be prevented by the surgeon handling the pancreas with great care, by his avoiding unnecessary explorations of the common duct, and by his exercise of extreme care when performing pancreatic biopsy.

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THE SWEAT GLANDS AND SUPPURATIVE HIDRADENITIS

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THE purpose of this presentation is to draw attention to an infective condition affecting the skin of the axilla and peri-anal region, which owes its distribution to the existence of a special form of sweat gland. The opportunity has been taken to review the morphology of sweat glands.

It is suggested that an awareness of the condition may be of some value in the management of chronic infections in those regions.

Historical

Purkinje is credited with discovery of the sweat glands in 1833, whilst Krause, in 1844, first observed that those in the axilla, about the anus and in certain other areas were larger that the rest. A detailed description of these glands was given by Robin (1845). It was not until 1922, however, that the morphology and nomenclature of the cutaneous glands received the clarification it now enjoys. Schiefferdecker classified the types of glands, described them, and attached to them some phylogenetic significance.

The association of peri-anal infection and abscess formation with similar changes in the axillary and mammary regions was recognized in the nineteenth century, Velpeau (1839) being the first to record the condition. By virtue of its distribution the disease became established as an entity. However, any connection with the apocrine sweat glands had to await recognition of these glands by the anatomists. In the light of Robin's work, Verneuil in several papers between 1854 and 1865 established that the infection arose in the special sweat glands of these areas.

Morphology of the cutaneous glands (Fig. I)

The developing hair follicles first appear as epidermal buds in the fourth and fifth months of foetal life. It is from similar buds and indeed from developing hair follicles themselves, that the various cutaneous glands have their origin. Being glands of external secretion we call them "exocrine" and three different types are recognized according to the nature of the secretion of the glands.

(a) Holocrine glands

Their secretion is formed by the breakdown products of whole cells which appear to be sequestrated from the centres of the gland acini. The sebaceous glands are of this type — they are appendages of the outer root sheath of the hair follicle. Meibomian glands are also of this type. Sebaceous glands are distributed all over the body surface, but most densely on the scalp, forehead, face, chin and extensor surfaces of limbs. They develop as an outgrowth of the hair follicle, to form a gland of multiple acinar type. The central closely packed cells in the acini show lipoid accumulation and fragmentation. Sebum in the lumen consists of lipids and cell debris. The gland is situated superficially in the dermis (Fig. II).

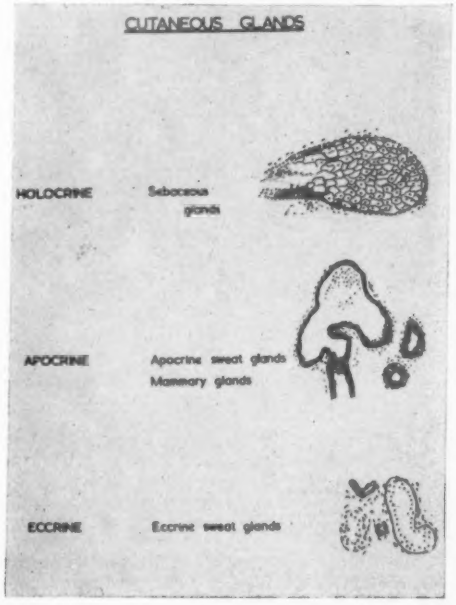

FIG. I.

(b) Eccrine glands

These produce their secretion without any disruption of the cell itself, the secretory material being liberated at the free border of

the cells of the acini. The majority of human sweat glands are of this type. Only the lips, glans penis and clitoris and the inner surfaces of the prepuce are free of these glands. They are most numerous on the palms and soles, where they reach a density of 400 per sq. cm. The gland is a simple tubule, the secretory portion being coiled and lying superficially in the dermis. The excretory duct leads up through the epidermis (where it is again coiled) to open on to the skin surface (Fig. III). Pyramidal cells line the small secretory tubules. Activity commences within a few months after birth, the fluid being transparent and watery.

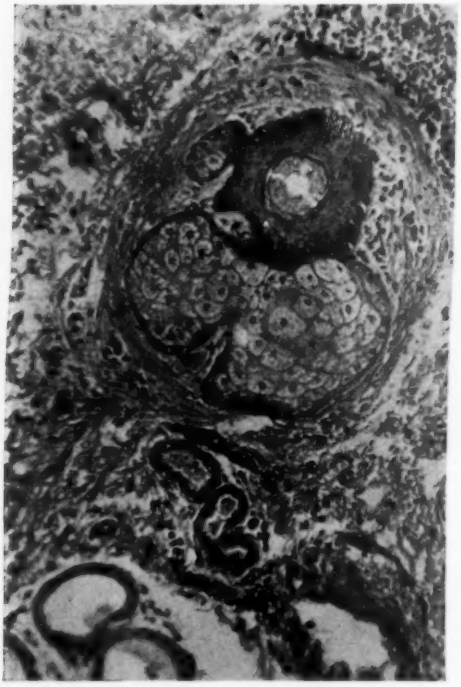

FIG. II. Sebaceous gland surrounding a hair follicle.

(c) Apocrine glands

These form their secretion by surrendering part of their cell substance — the free border of the cell accumulates secretory material prior to its detachment. The apocrine sweat glands and the mammary gland are of this type.

Apocrine sweat glands are quite readily distinguishable from eccrine sweat glands. They are found in groups occurring in the axilla, the mons veneris, labia minora, prepuce and scrotum, circum-anal region, the areola and nipple and in the external auditory meatus. Occasional glands are found on the face and about the umbilicus.

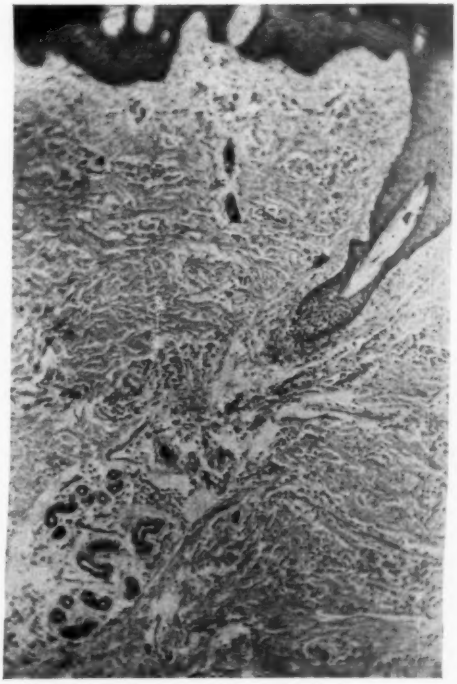

FIG. III. Eccrine sweat gland.

The glands are much larger than the eccrine type, being situated deep in the dermis, in relation to hair follicles (Fig. IV). They are visible to the naked eye (on examining the dermal surface of axillary skin from which the fat has been removed) as prominent red lumps up to 5 mm. in diameter.

The coiled tubules of the gland are lined by columnar or cuboidal cells, with a brush border, lying on a basement membrane composed of myo-epithelial cells. The duct shows a double cuboidal layer, and usually opens into the hair follicle below the sebaceous gland. Some glands appear to open directly on to the skin.

The apocrine sweat gland develops as an outgrowth from the hair follicle, during the 6th foetal month; final development and activity is related to sexual maturity. (The

glands could not be recognized as such in many sections taken from the axillae of newborn babies. Likewise, the active glands of younger people could not be identified in the axillae of patients over 70.)

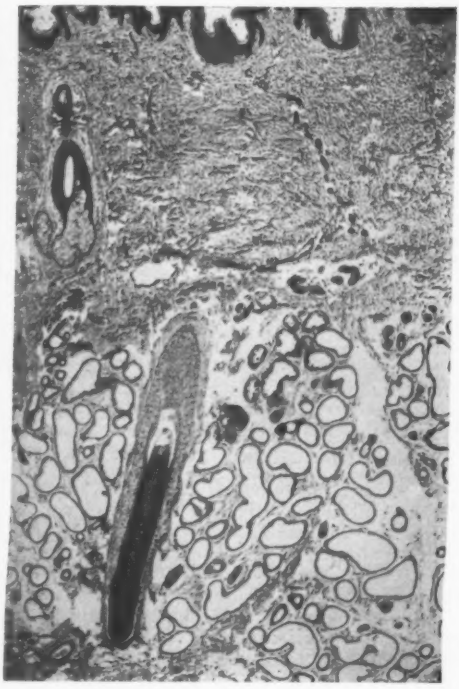

FIG. IV. Apocrine sweat gland.

The secretion has the characteristic odour of the unclean axilla and is whitish-grey or yellowish in colour. In some sections the cells of the tubule show an intact basal portion, the free end being apparently "pinched off" to give rise to the secretion.

There are, then, two distinct types of sweat gland, clearly differing in the nature of their secretion. The distribution of the apocrine and eccrine glands varies in different species and was the subject of controversy in the 1920's. Eccrine sweat glands attain their best development in the primates and particularly in man. In other mammals very few of them are found, usually on the volar side of the paws and digits. The sweat glands in the horse, dog and pig are of apocrine type. The animal kingdom may thus be arranged according to the ratio of eccrine to apocrine glands, only man and the chimpanzee having more eccrine than apocrine. Attempts were also made to arrange a descending order among human racial species (Homma, 1926) — a small series, showing decreasing apocrine gland numbers, from Australian aborigines, to negroes, to European races, purported to indicate these people's places on the evolutionary scale. Woollard (1930) in an exhaustive study of Australian aborigines was able to disprove this.

SUPPURATIVE HIDRADENITIS

Case history

Mr. S., aged 43 years, an aircraft inspector, presented in March, 1957, complaining of persistent painful swellings in the axillae, mainly on the left side, for four years. These swellings he likened initially to boils — lately, however, there had been considerable thickening in the armpit and a continuous discharge of foul pus. Over the past three years a similar condition had appeared about the anus. Abscesses had been incised on several occasions and now there was more or less continuous discharge of small amounts of pus.

Examination showed a swarthy man of solid build in robust health. The skin of his face, neck and chest showed many small pitted scars, the aftermath of superficial infection. Both axillae contained the normal amount of hair; in the left axilla the skin contained several raised red lesions, some with pus in their centres, others discharging thin yellow pus. These abscesses were quite tender and the lesions were connected within the skin by a considerable area of induration (involving all the hair-bearing area), raised in firm cords between the abscesses. This area was not attached to the deep fascia.

In the peri-anal region the changes were most marked in the natal cleft, about 5 cms. behind the anus, but extended laterally on both sides. Appearances were similar to the axillary lesions, with several discharging sinuses surmounting an irregularly indurated area. There was a margin of healthy skin 5 cm. wide surrounding the anus, and no changes were apparent on rectal examination. Apart from a right inguinal hernia there were no other positive physical findings.

The peri-anal lesion brought to mind a diagnosis of pilonidal infection, or perhaps of anal fistula; however, its association with the axillary infection required explanation and so the case became recognized as one of suppurative hidradenitis.

The acute inflammatory changes subsided (though incompletely) with simple local measures; it was apparent that recrudescence would readily occur, however. Accordingly, at the time when improvement seemed greatest, radical excision of the skin and subcutaneous tissues of the involved areas was undertaken, all tissues down to the deep fascia being removed. Split skin, cut with the dermatome, was applied to the defect and adhered successfully.

Over the ensuing months, the patient has been quite free of his former trouble. Arm movement has not been restricted by any tightness in the axilla.

Pathological examination of the material was of considerable interest (Fig. V). The deep layers of the dermis were the seat of the inflammatory changes, which were seen to involve and disrupt a band of

quite large tubular glands. The more superficial regions, in which the common sweat glands are seen, were not involved. This was taken to confirm the clinical diagnosis.

Infection seems to occur only in the actively functioning glands of the adult. Perhaps many cases pass unrecognized, particularly in the axilla.

FIG. V. Suppurative hidradenitis. An inflammatory focus is disrupting the apocrine glands, situated deep in the dermis.

The early clinical features are indistinguishable from the everyday boils and furuncles. It is characteristic of these conditions, when occurring in the axilla to show multiple foci of infection and to show incomplete response to the usual measures. A chronic stage may ensue with considerable scarring and distortion of the axilla, and intermittent discharge. The characteristic nodules and sinuses take perhaps a month or two to become established.

A more widespread condition may be seen occasionally, especially in the peri-anal area. Infection spreads in the deeper layers of the dermis, with areas of suppuration and fibrosis. Long sinus tracks and ulcers with undermining edges may involve large areas of the buttocks.

There appears to be no specific bacteriology, bowel flora commonly occurring in the peri-anal lesions, whilst staphylococci or mixed infection is seen at other sites.

The condition has been produced experimentally (Shelley and Cahn) by bacterial infection of apocrine sweat glands obstructed by the application of adhesive tape. Trauma, chemical dermatitis and the use of depilatory agents (manual and chemical) may play a part.

It would appear that infection harbours within the substance of the apocrine glands, giving rise to recurrences after temporary healing. The apocrine secretion is apparently a more favourable bacterial medium than that of the eccrine glands.

Diagnosis is rendered easier if the condition occurs simultaneously in several of the characteristic sites; the proctologist bears it in mind in the unusual case of peri-anal infection. Lympho-granuloma inguinale, actinomycosis and tuberculosis, maye be suspected.

Transition to a chronic state is perhaps not the rule, for the established chronic case is indeed a rarity. It is only in this stage that treatment presents a major problem and nothing seems more satisfactory than complete excision of the involved areas and skin replacement.

SUMMARY

The morphology of the cutaneous glands is reviewed, with particular reference to the apocrine sweat glands. The latter have been studied by macroscopic and histological examination of axillary and perineal skin from newborn babies, adults and the very elderly. The apocrine glands are situated deep in the dermis, and are found in the skin of the axilla, mons veneris, perineum, about the anus, in the external auditory meatus, and around the nipples. Unlike the common eccrine sweat glands, they are not fully developed until puberty, and only then give rise to their characteristic secretion. They remain active until old age, when retrogression occurs.

Infection of the apocrine glands occurs, and is recognised by its characteristic distribution (affecting simultaneously the axilla and perineum) and its tendency to incomplete resolution and recrudescences. A typical case history is presented. Wide excision of the involved skin and subcutaneous tissue, with graft replacement, has proven a successful means of treatment.

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CARCINOMA OF THE THYROID GLAND IN CHILDHOOD

ITS RELATION TO RADIOTHERAPY

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CARCINOMA of the thyroid gland, although not a common childhood malignancy, is being diagnosed with increasing frequency.

One of its most interesting facets is the part played by irradiation in its aetiology.

Review of the Literature

A large number of cases have been recently published in all of which irradiation of the neck or upper thorax, and hence of the thyroid gland, has preceded the development of thyroid malignancy. The thyroid cells of the child are apparently susceptible to this stimulus to an extent which is not reproduced in later life as noted by Duffy (1957).

In 1950 Duffy and Fitzgerald reported 28 cases of carcinoma of the thyroid in patients under the age of eighteen years, 10 of whom had had irradiation to the thymus in infancy.

Clarke (1955) recorded 15 children with carcinoma of the thyroid, all of whom had received irradiation to the neck (4 for "enlarged thymus" and 11 for other benign conditions). The interval between irradiation and the diagnosis of thyroid cancer varied from three to ten years (average 6.9 years).

Winship, in 1956, collected, by perusal of the literature and the sending out of questionaires, 334 cases in which carcinoma of the thyroid had occurred before the age of fifteen years. Twenty per cent. of these had had earlier irradiation of the thymus.

In 1957 Simpson and Hempelmann reported the study of 1,722 children who had had irradiation to the thymus during the preceding twenty-seven years; ten had developed carcinoma of the thyroid. These children had one thousand nine hundred and thirty-three siblings who did not receive irradiation. Over the same period of time none of these developed cancer.

Petit, Catz and Starr in 1958 reported 11 cases of carcinoma of the thyroid in subjects under the age of twenty-one years. Nine of these had had previous irradiation to the head and neck area (two for "enlarged thymus" and seven for other benign conditions). The age at which irradiation was administered varied from one to eight years and the latent period prior to the diagnosis of malignancy from four to thirteen years.

Also in 1958 appeared the communication of Wilson *et alii* in which are reported seven cases of thyroid carcinoma, all of which had preceding irradiation of the neck. Two of these cases were in children. Both malignancies were of the papillary type and the initial irradiation to the gland was in one case 160 r and in the other 260 r.

In 1959 Rooney and Powell published 10 cases of carcinoma of the thyroid under the age of seventeen years. Seven had had irradiation to the neck (four for thymic enlargement and three for other lesions).

The present writer has treated three cases of thyroid carcinoma in children, all of whom had irradiation to the neck during the first year of life. The diagnosis was established at the ages of twelve, fourteen and eleven years respectively, but, in the first two, lumps in the neck were known to have been present since the age of ten years (these were of the papillary adenocarcinoma type and were reported by Webster and Howard in 1954, at which time the facts regarding their early irradiation were not appreciated). In each of these cases the neck was irradiated for eczema but the dosage is not known.

The third case is now recorded.

Case Report

R.P., a girl aged eleven years, was referred to the writer on 5th December, 1958.

A lump on the right side of her neck had been noticed by her mother seven weeks previously and

biopsy of this had shown it to consist of lymph nodes invaded by thyroid carcinoma.

The history was elicited that irradiation treatment of a cutaneous haemangioma in the region of the chin had been commenced shortly after birth and continued over the first year of life. A total dosage of 2,400 r was used.

Examination of the neck was rendered difficult owing to the reaction around the biopsy incision. It appeared, however, that the right lobe of the thyroid gland was enlarged and hard and that there were some isolated masses over the trachea in the suprasternal area. At least one considerably enlarged lymph node was present under the middle of the right sternomastoid muscle. Two slightly enlarged nodes were palpable rather high in the anterior triangle on the left side of the neck.

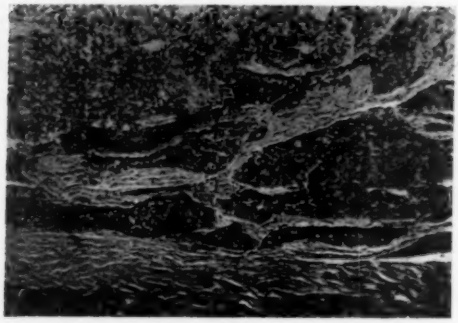

FIG. I. R.P., thyroid gland, low power.

X-ray examination of the lungs showed no abnormality.

Operation was performed on 12th December, 1958. The right lobe of the thyroid gland was found to be occupied by a malignant mass which also involved the isthmus and extended on to the left side close to the trachea. There was extension of the growth inferiorly along the anterior surface of the trachea and into the juxta-thyroid tissues on the right side. Both recurrent nerves were involved and the trachea itself was extensively infiltrated. The right lobe of the thyroid was removed but growth was left around the right recurrent nerve. The thyroid isthmus was also excised but here the malignancy had extended into the trachea and removal was incomplete. One very large and several smaller nodes, extensively invaded by malignant tissue, were excised from the middle section of the right side of the neck. The two nodes on the left side of the neck were removed and subsequently proved to be innocent.

Dr. R. Webster reported on lymph nodes and thyroid gland proper as follows:—

"Both pieces of tissue are identical in structure which is that of a carcinoma exhibiting differentiation varying from anaplasia to well differentiated colloid vesicular adenocarcinoma." (See Figs. I and II).

Subsequent treatment has been by means of irradiation with the cobalt bomb and the administration of three and later four grains of thyroid extract daily. On this regime the child has continued well up till the time of writing (eight months after operation).

CONCLUSIONS

It would seem that the relationship of irradiation of the thyroid during the early years of life to the subsequent development of cancer in this gland is a definite one. Furthermore, it appears that the cells of the adult thyroid do not exhibit the same tendency to develop cancerous properties in response to a similar stimulus.

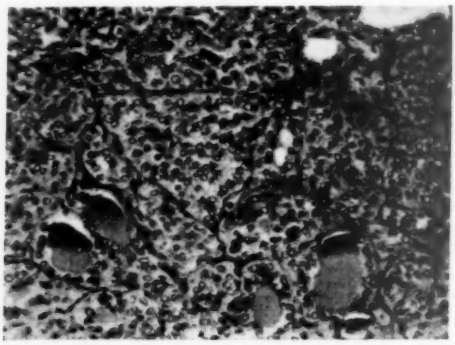

FIG. II. R.P., thyroid gland, high power.

The initial irradiation has been given for a variety of conditions and, although "enlarged thymus" has probably been the commonest of these, there is certainly no reason for more directly inculpating this gland in the aetiology of the thyroid malignancy.

The amount of irradiation necessary to produce malignancy does not need to be large. There is probably a critical level below which exposure is harmless. The lowest recorded activating dose is that of 160 r mentioned by Wilson *et alii*. Clarke stated that each of the fifteen cases which he reported received 200 r or more, whereas 1,722 cases who had less than this dosage failed to develop cancer.

The latent interval between irradiation and development of carcinoma is very variable, limits of from three to seventeen years have been noted (Wilson *et alii* record a latent

period of twenty-seven years in an adult). Again this interval seems to have no relation to the dosage of X-rays.

SUMMARY

1. Attention is drawn to the relationship of irradiation of the thyroid gland in infancy and childhood to the subsequent development of carcinoma in this gland.

2. Supplementary information is furnished concerning two of the children suffering from carcinoma of the thyroid gland whose case histories were reported by Webster and Howard in this journal in 1954. It is suggested that irradiation is likely to have been implicated in their aetiology.

3. Record is made of a further case of carcinoma of the thyroid gland in childhood in whom irradiation of the neck preceded the development of malignancy.

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PERFORATION OF THE COLON IN LARGE BOWEL OBSTRUCTION DUE TO CARCINOMA*

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THE development of obstruction in a patient with a large bowel neoplasm is a serious complication and produces, of itself, a significant increase in the immediate mortality from this disease. When perforation of the obstructed colon supervenes, the patient's chance of survival becomes slight, so slight in fact that many surgeons believe that the precise type of surgical intervention in these cases is of no importance and state that, no matter what is done, a fatal issue is inevitable. Our experience would suggest that this gloomy outlook is unjustified and that, although the prognosis is grave, death is not unavoidable. One of us has intervened in five cases of this emergency and three of these have survived.

Despite the use of antibiotics and the application of our knowledge of the disturbances of fluid and electrolyte balance, which occur in severe peritonitis, the mortality of this condition remains distressingly high. Moreover, as will be pointed out later, most of these patients are found to have a resectable neoplasm and, if they recover from the initial catastrophe, may be expected to have a reasonable chance of long-term survival.

Under these circumstances, it is essential that the method of treatment employed at the initial operation should be that designed to give the patient his best chance of survival. Since there is no agreement among surgeons as to what constitutes the appropriate operative procedure, it was decided to collect and review a group of these cases in the hope that retrospective analysis would provide some guide for the treatment of future cases.

*This work was carried out whilst the authors were holding a grant from the Anti-Cancer Council of Victoria.

Material

This series consists of those patients treated at the Royal Melbourne Hospital during the period 1944-58, in whom a diagnosis of general peritonitis due to perforation supervening on carcinoma of the colon was made, either clinically, at operation, or at autopsy. In all cases the diagnosis was confirmed either at operation or by post-mortem examination. Those cases in which slow perforation occurred with the formation of a pericolic abscess were not included. There were 34 cases (17 males and 17 females) aged from 38 to 81, with an average age of 63.

Table 1

PRE-OPERATIVE DIAGNOSIS

General peritonitis		26
(1) Due to perforated carcinoma	16	
(2) Due to other causes	10	
Perforated peptic ulcer	3	
Perforated appendix	2	
Perforated diverticulitis	1	
Peritonitis ? aetiology	3	
Acute pancreatitis	1	
Large bowel obstruction		8
	Total:	34

Clinical Features

The outstanding feature which emerged after a preliminary survey of these cases was that in less than half of them a complete diagnosis had been made pre-operatively. Table 1 outlines the diagnosis made after examination in the ward, supplemented in some instances by special investigations. In 26 cases the presence of a general peritonitis was recognized, whereas in eight cases the diagnosis of large bowel obstruction was

made. In only 16 cases was a complete diagnosis made pre-operatively. This problem of diagnosis may be considered under three headings:—

(i) Diagnosis of carcinoma of the colon.

(ii) Diagnosis of large bowel obstruction.

(iii) Diagnosis of peritonitis.

(i) *Diagnosis of carcinoma of the colon*

Although it is easy to be wise after the event, it seems to us not unreasonable, on analysis of the evidence as presented in the case records, that a positive diagnosis of carcinoma of the colon might have been possible in 20 cases.

Fourteen cases had a classical history, two had a palpable mass and suggestive history and in 4 cases special investigations (barium enema, 2; laparotomy, 2) prior to admission had indicated the diagnosis.

In 14 cases the presence of a carcinoma was not suspected. Three were considered to have perforated peptic ulcers since they presented with a sudden onset of severe abdominal pain and had no antecedent history. The remaining 11 patients all gave a vague history of bowel upset, but neither clinical examination nor special investigation made the diagnosis of carcinoma of the colon apparent.

The length of history (Fig. I) was variable — up to two years, but generally quite short. Half of the cases had a history of less than three months and two-thirds had less than six months history.

(ii) *Diagnosis of large bowel obstruction*

Two-thirds of the patients had large bowel obstruction with a history of constipation, distension and colicky abdominal pain and in half of these there was complete constipation for from two to twelve days prior to admission. The remaining third had noticed no recent change in bowel habit.

(iii) *Diagnosis of perforation*

In a retrospective review such as this it is difficult to assess the time interval between the onset of perforation and presentation at hospital. Excluding those cases in which the history was stated to be unreliable, or in whom an estimate of time of perforation was not made, it was found that the patients fell into two well-defined groups:—

1. those who had a sudden onset of severe pain and,
2. those who had a gradual increase in the severity of their pain.

As would be expected, those in whom perforation occurred dramatically presented earlier than the second group — in a matter of hours rather than days.

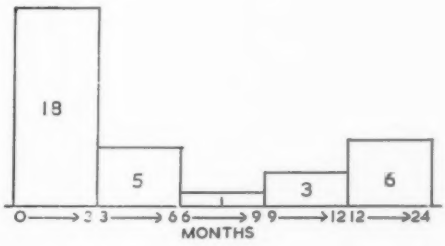

FIG. I. Diagram showing duration of symptoms prior to admission with perforation. It is to be observed that two-thirds of all cases presented within six months of the onset of their symptoms. Difficulties of retrospective analyses precluded subdivision of the 12-24 months group. In one instance the length of history was not recorded.

The site of pain was usually central or lower abdominal and was no guide to the possible site of perforation. Examination usually revealed abdominal distension, the abdomen being described as tense or rigid, with generalized or lower abdominal tenderness. Free fluid and gas were not commonly detected clinically and alteration in bowel sounds was not frequently commented upon.

In this series few patients were subjected to special investigations. A straight X-ray of the abdomen was that most often employed and even this was not of great help since, in the four cases in which gas was detected under the diaphragm, a firm diagnosis of perforation had already been made on clinical grounds (Fig. II).

SURGICAL PATHOLOGY

Site of tumour

The normal pattern of occurrence of carcinoma in the various regions of the colon is well known and, as one would expect, the site of the tumour in this series followed this pattern (Fig. IIIa).

Site of perforation

Perforation of the colon may occur through the neoplasm, just proximal to an obstructing carcinoma or through the caecum. In this series the site of perforation was almost equally distributed between these three groups (Fig. IIIb).

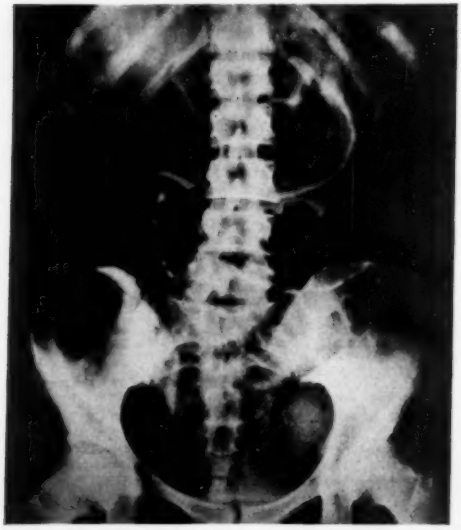

FIG. IIa. X-ray of the abdomen of a patient suffering from perforation of the large bowel showing the loops of distended bowel.

Contamination

The degree of peritoneal soiling was difficult to assess as the reports were those of a large number of observers. It did appear, however, that the soiling was generally light to moderate when perforation occurred through the neoplasm, whereas the contamination was moderate to heavy at sites proximal to an obstruction (Fig. IV).

It might be expected that in those patients in whom perforation occurred dramatically, there would be gross faecal contamination due to a large perforation occurring proximal to an obstructing carcinoma or through a grossly distended caecum. Analysis of these cases, however, revealed that although contamination was generally heavy, the size of the perforation was extremely variable (from pin-hole size to 2 cm. in diameter) and that no one site was more common than another (Table 2).

TABLE 2

CASES WITH DRAMATIC PERFORATION

Perforation through neoplasm	5
Proximal perforation	10
Light contamination	3
Heavy contamination	12
Size of perforation	very variable

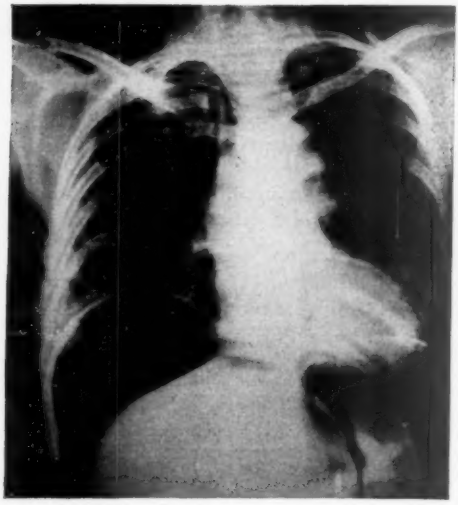

FIG. IIb. X-ray of the chest of the same patient showing gas under the diaphragm. The spleen is clearly outlined.

Spread

Twenty-nine of the patients (85 per cent.) in this series had an eminently resectable neoplasm (proven in the majority by post-mortem examination) and of this group, only two had spread to the immediately adjacent lymph nodes. Of the remainder, four had distant spread and in one instance perforation was a terminal event in a patient with proven carcinomatosis (Table 3).

METHODS OF TREATMENT

On analysis of the methods of treatment employed in these cases it became apparent that there occurred a natural subdivision into five groups (Table 4). Each group will now be considered in detail.

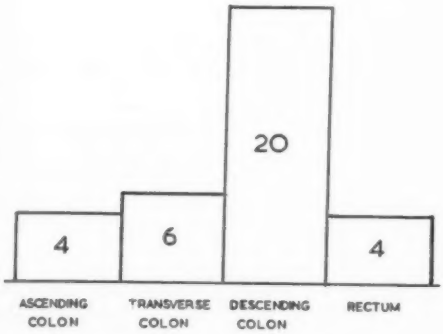

FIG. IIIa. Diagram illustrating the distribution of site of neoplasm in the colon. This distribution parallels that of uncomplicated carcinoma.

(1) *Untreated*

Three patients in this group were not operated upon because of their poor general condition. Two were admitted in a moribund state, having had the presence of carcinoma established at a previous operation — one having had a right hemi-colectomy and the other a transverse colostomy for an inoperable carcinoma of the recto-sigmoid. The third was considered too sick for operation because of associated medical conditions.

TABLE 3

SITE OF METASTASES

Adjacent lymph nodes		2
Distant spread—		
Liver	2	
Lungs	1	
Ovaries	1	
		4
Carcinomatosis		1
	Total:	7

The remaining four in this group all perforated while in hospital. Three were being managed conservatively, two as a large bowel obstruction and the third as an appendicular abscess. The fourth was convalescing three weeks after transverse colostomy (which had functioned well) for an inoperable carcinoma of the sigmoid colon. In all cases they suddenly deteriorated and died and the occurrence of perforation remained unsuspected until post-mortem examination.

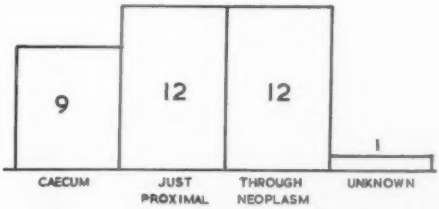

FIG. IIIb. Diagram showing the distribution of the site of perforation in relation to the neoplasm. It is seen that perforation occurred with equal frequency through the neoplasm, just proximal to the neoplasm, and through the caecum.

(2) *Simple drainage*

Drainage of the peritoneal cavity was instituted in five cases, supplemented in one instance by suture of the perforation. Only one case survived and this patient had minimal localized soiling of the peritoneum. In only one instance did anxiety concerning the patient's general condition influence the surgeon's choice of treatment.

TABLE 4

METHODS OF TREATMENT

Method	*No. of Cases*	*Survivors*
No treatment	7	–
Simple drainage	5	1
Colostomy and drainage	12	–
Exteriorization of perforation	5	2
Resection of perforated bowel	5	3

(3) *Colostomy and caecostomy*

The addition of colostomy or caecostomy to drainage of the peritoneal cavity added nothing to the survival rate — all 12 patients died. Post-operative deterioration was gradual, death occurring on the average on the sixth post-operative day. Once again, in only one instance did the patient's poor condition restrict the surgeon's activities.

In three cases the perforation was minute and not identified at the time of operation,

although in one case there was free faecal matter in the peritoneal cavity. The other two had no faecal contamination and yet, despite an adequately functioning colostomy and drainage of the region of the neoplasm (which subsequently proved to be the site of perforation), they slowly deteriorated and, at post-mortem, were all found to have gross faecal contamination of the peritoneal cavity.

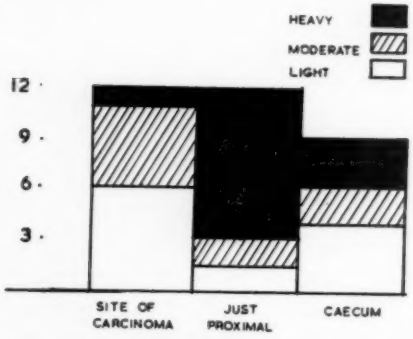

FIG. IV. Diagram showing the degree of peritoneal soiling following the various types of colonic perforation. Perforation through the neoplasm itself is likely to produce less soiling of the peritoneum than is perforation through the obstructed colon.

(4) *Exteriorization of the perforation (five cases)*

Two cases in this group may be rapidly dismissed. One was admitted three days after the occurrence of perforation. He rapidly deteriorated during the induction of anaesthesia. Operation revealed gross faecal contamination and despite ileostomy and exteriorization of a grossly gangrenous and perforated caecum he failed to respond.

The other also had a caecal perforation exteriorized. However, post-mortem revealed this to be inadequate as the whole caecum including the intra-abdominal portion was gangrenous. This is an important point and will be mentioned again later.

The remaining three all had gross faecal contamination. One who was shocked preoperatively failed to survive exteriorization of a perforated carcinoma of the hepatic flexure. The other two had perforation of the sigmoid colon — one through a neoplasm and the other through a stercoral ulcer proximal to an obstructing carcinoma of the recto-sigmoid junction. Both survived exteriorization of the sigmoid and subsequently had successful resection of their neoplasms.

If one may pause at this juncture to consider the methods of treatment outlined so far — here for the first time there is a small but significant improvement in results. It would appear that removal of the perforated colon from the abdominal cavity is thus a worthwhile procedure.

(5) *Resection of the perforated bowel*

This group of five cases contains the greatest number of survivors; it is thus proposed to deal briefly with each individually.

Case 1

A 69-year-old woman, with a carcinoma of the recto-sigmoid junction. She presented with a two-day history of absolute constipation and on examination had the signs of a generalized peritonitis. Preoperatively, her condition was poor. Operation revealed a gross faecal peritonitis resulting from multiple perforations of a gangrenous sigmoid colon. The sigmoid was resected and the proximal end brought out as a terminal colostomy. However, she failed to respond.

Case 2

A 61-year-old man, presenting with gross faecal peritonitis due to a perforated carcinoma of the caecum. Immediate right hemi-colectomy was performed, but he slowly deteriorated and died on the second post-operative day.

Case 3

A 65-year-old male was admitted to hospital with a twelve-hour history of sudden onset of severe abdominal pain. He had had the classical signs of subacute large bowel obstruction over the preceding three months. Laparotomy revealed free perforation with a stercoral ulcer immediately above a neoplasm in the sigmoid colon. An uneventful recovery followed a Hartmann's operation.

Case 4

A wiry, 80-year-old Scotsman, who had gross faecal contamination of the general peritoneal cavity following perforation of the sigmoid colon proximal to a carcinoma of the recto-sigmoid. Hartmann's operation was performed and, despite a disruption of the abdominal wound, he continued to improve and was discharged home well.

Case 5

A 56-year-old woman was admitted to hospital with a three-month history of increasing constipation. Over the preceding three days constipation had been absolute and six hours prior to admission she had been seized by sudden severe abdominal pain. Perforation of a carcinoma of the colon was diagnosed and an X-ray of the abdomen (Fig. II) confirmed this diagnosis.

Laparotomy revealed a carcinoma of the sigmoid colon and a perforation of the caecum with heavy peritoneal soiling. The right colon was excised and an ileostomy performed. Later the sigmoid neoplasm was resected and the ileostomy closed.

DISCUSSION

Perforation of the colon naturally follows the age distribution of carcinoma of the large bowel and therefore may be expected to occur on occasion in patients suffering from established cardiovascular, pulmonary or renal disease. Moreover, the faecal contamination of the peritoneum which attends this disaster, leads inevitably to a severe degree of peritonitis, and thus in any group of patients suffering from this condition many will perish as a result of either, or both, of these factors. However, the present investigation indicates that death is not inevitable and that survival is to some extent related to the type of surgical procedure employed.

As is to be expected, no patients survived when the condition was untreated. Simple drainage gave no better results — the one case which survived this measure had such mild contamination of the peritoneum that it can barely be classified as a case of free perforation.

The addition of colostomy to the procedure of simple drainage was singularly unsuccessful. There were twelve such cases and none survived. Moreover, two of these cases developed their perforation in the presence of a properly functioning colostomy, and two further cases, stated to have a pin-hole perforation and an insignificant amount of faecal contamination at laparotomy went on to develop a gross and fatal faecal peritonitis. It is not unreasonable to enquire why simple diversion of the faecal stream fails to give better results than have been indicated. The recovery potential of the patient after peritoneal contamination is well recognized and it is also appreciated that continued infection of the peritoneum is far more serious than is an isolated episode of faecal soiling. Now it is apparent that perforation in association with colonic obstruction may occur in three ways:—

1. Infection and necrosis of the tumour mass itself may go on to free perforation (Fig. V).
2. Impacted faecal masses immediately above the obstruction may be associated with stercoral ulceration of the bowel wall and these stercoral ulcers may perforate.
3. Gross distension of the acutely obstructed colon produces multiple mucosal ulcers related to the areas of venous occlusion (van Beuren, 1926). Ultimately, one or more of these ulcers which occur mainly in the caecum and ascending colon (this section of the bowel distending to the greatest extent) perforates (Saeltzer and Rhodes, 1935).

FIG. V. Photograph of specimen showing carcinoma of the caecum. In the centre there is a black area of full thickness necrosis, through which free escape of the bowel content had occurred.

It is important to appreciate that at the time when perforation chances to occur in any one ulcer there are probably many others present in the caecum and ascending colon which are on the point of rupturing. After perforation has occurred and the distended bowel collapses the presence of these multiple areas of potential further perforation is easily overlooked. Moreover, these multiple ulcers provide bacteria with a ready means of access to the caecal wall, a structure already badly damaged by the affects of prolonged distension. The widespread nature of these

changes in obstructed bowel has been emphasized by Wangensteen (1955), who records their production in the experimental animal.

Thus, it can be seen that transverse colostomy or caecostomy suffers from the major defect that these procedures leave within the peritoneum a potential source from which continued contamination will occur. Bearing these facts in find, it seems reasonable to suggest that improved results may follow operative procedures designed to resect or exteriorize the length of damaged bowel. Review of our material would indicate that this postulate is correct, for on the ten occasions in which these procedures were employed five of the patients survived. Whilst it is true to say that only one case in twenty-four survived when the bowel was left in situ, these figures do not accurately reflect the difference in outlook since the latter group included seven cases in which no operative intervention was carried out.

In the cases under review exteriorization of the bowel was performed in five cases and excision of the perforated bowel in a further five. Whilst the results show little difference between the two groups it is felt that actual excision of the devitalized gut is a more satisfactory procedure than is simple exteriorization. So that the exteriorization of the bowel can be adequately carried out, mobilization of the colon is often necessary and the additional trauma of removal of the mobilized gut is negligible. Mobilization of the gut has been criticized on the grounds that opening up retroperitoneal tissue planes in the presence of gross faecal contamination will lead to a fatal retroperitoneal cellulitis. Cases reported in this paper indicate that this fear is more theoretical than real; in one patient who died following a resection of his colon, inspection of the retroperitoneal tissues at autopsy failed to reveal any evidence of cellulitis.

Exteriorization of damaged or devitalized colon is of recognized value in the treatment of colonic wounds and it would seem reasonable to apply these same principles to a colon damaged not only by the presence of a perforation but also damaged by the effects of long continued obstruction and ulceration.

Many surgeons criticize the use of an extensive operation, such as colonic resection, on the grounds that patients suffering from peritonitis are too sick to undergo a major procedure. In this series, this argument was not substantiated and it was seldom recorded that anxiety concerning the patient's general condition at operation influenced the surgeon in his choice of treatment. Those who survived resection were in the main elderly and showed gross faecal contamination. Indeed, their prospects of survival on admission seemed no better than those of any other member of the series.

The low mortality of gastric resection in the presence of free perforation is now well established and the results of this review would suggest that patients will survive an equally extensive surgical procedure, even though the severity of the peritonitis is much greater than that seen in perforation of a peptic ulcer. Excision of the damaged colon removes the hazards of continuing peritoneal infection and thus the over-all mortality is less when the colon is removed than it is when less extensive and less adequate procedures are carried out.

This subject has received little attention in the literature. Hendelberg (1945) appreciated that perforation may occur quite early in the natural history of the disease (an observation borne out by our experience), although most of his cases showed merely abcess formation and not gross peritonitis. Inberg and Purannen (1953) reviewed 81 cases of carcinoma of the colon, of which 15 were complicated by the presence of acute obstruction. In this group of 15 cases, two had perforated and the authors were impressed by the poor prognosis of perforation, although their figures were too small to be of great value.

Mersheimer and Miller (1954) reviewed 21 cases of free perforation of which only three survived. It is of considerable interest to note that the three survivors detailed in this report were treated either by resection or by exteriorization of the perforated bowel. Goligher and Smiddy (1957) investigated both localized and free perforation in association with carcinoma of the colon and discovered an over-all incidence of approximately 7 per cent. in 1,644 colonic neoplasms.

This series included 57 cases of free perforation and the authors concluded that perforation was not, of necessity, a hopeless condition and advised that the perforation be exteriorized if it were in close proximity to the causative neoplasm.

Donaldson (1958) recorded 182 cases of perforation in association with colonic neoplasm collected from the Massachussetts General Hospital; this series representing an incidence of 8 per cent. of all cases of colonic neoplasm admitted to that institution. Of these, about one-third had free perforation and once again the author concluded that resection or exteriorization offered the best prospects of survival.

SUMMARY AND CONCLUSIONS

1. Free perforation of the obstructed colon due to carcinoma has, not without reason, a sinister reputation.
2. With the aid of modern methods of resuscitation and antibiotics, recovery from this catastrophe is possible.
3. In order to ascertain the results of various methods of surgical management 34 cases were surveyed.
4. Untreated, the condition is uniformly fatal.
5. Simple drainage is little better than no treatment; the only patient surviving had only minimal contamination of the peritoneum.
6. The addition of colostomy or caecostomy to the procedure of drainage was uniformly unsuccessful. It is suggested that the reason for this is that continued infection of the peritoneum occurs from bowel severely damaged by distension and ischaemia.
7. The logical conclusion from the cases reviewed is that the perforated bowel should be exteriorized or excised. Where these procedures were carried out the results wert obviously better.
8. It is suggested that, for various reasons, excision of the devitalized bowel is preferable to simple exteriorization.
9. Review of the literature indicates that other authors have reached similar conclusions.

ACKNOWLEDGEMENTS

We wish to thank the honorary medical staff of the Royal Melbourne Hospital for permission to review the relevant case records.

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COMBINED COMMON BILE DUCT AND PANCREATIC DUCT INJURY OCCURRING DURING GASTRECTOMY

SUCCESSFUL REPAIR

By E. S. R. Hughes and Graham A. Syme

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THE common bile duct lies close to the pancreatic duct in the head of the pancreas. Just before penetrating the wall of the duodenum the two ducts become surrounded by a common fibromuscular sheath (Hughes and Kernutt, 1954). Occasionally a duodenal ulcer extends into the second part of the duodenum and in such circumstances the two ducts may be damaged during surgery.

The injury appears to be rare. Carpenter and Crandell (1958) reviewed the literature and could fine reference to only 8 cases. Apart from reports by Warren (1951, 1954) and by Carpenter and Crandell (1958) there is very little information available concerning the methods of repair and the late results.

In the case reported here the common bile duct and pancreatic duct were divided immediately proximal to the point where the two ducts were enveloped in the common fibrous sheath. The injury was recognized and a successful primary repair was obtained.

Case history

Miss C.H. (R.M.H. 162951), aged 56 years, had symptoms of duodenal ulcer for twenty years. She had numerous haemorrhages and on four occasions had been to the Royal Melbourne Hospital for transfusion but on each occasion refused surgery. For two years pain had been almost constant and radiated from the epigastrium through to the back. A barium meal on the 12th August, 1955, revealed a large chronic duodenal ulcer. Following readmission to the Royal Melbourne Hospital on the 20th September, 1955, with a severe bleed which showed no sign of spontaneous arrest she agreed finally to operation.

First operation: On the 27th September, 1955, a Billroth 1 type of gastrectomy was performed for a large chronic ulcer in the first part of the duodenum. Her convalescence was uneventful.

Progress after first operation: She was re-admitted on the 10th April, 1956, with auricular fibrillation and congestive heart failure after consuming considerable quantities of alcohol. With rest and digoxin she improved quickly and was discharged. A melaena was responsible for re admission on the 13th October, 1956, and 2½ litres of blood were required. A barium meal and gastroscopy were normal and she was discharged. Three weeks later after a sharp haematemesis she was re-investigated with negative findings. On the 14th December, 1956, she returned with a further haematemesis and melaena and on this occasion bleeding continued after admission. Emergency operation was advised.

FIG. I. The situation of the anastomotic ulcer.

Second operation: At midnight on the 16th December, 1956, laparotomy disclosed a large anastomotic ulcer on the posterior aspect of the gastro-duodenal anastomosis. The duodenum was opened and a bleeding artery in the base of the ulcer was oversewn. The ulcer had penetrated the pancreas, and in separating the duodenum from the lower edge of the ulcer the common bile duct and pancreatic duct were severed (Figs. I and II). The diameters of the distal end of the ducts were very small and this together with their situation in the edge of the duodenum to be inverted made end-to-end anastomosis impossible. It was decided to anastomose the cut lower end of the bile duct to the cut distal end of the pancreatic duct. This was achieved with a series of interrupted fine plain catgut through all layers re-inforced with an outer layer of fine silk. The open end of the duodenum was inverted and closed and a side-to-side anastomosis between the common bile duct and duodenum performed. A "T-tube" was inserted into the common bile duct

above the choledocho-duodenostomy (Fig. III). The operation was completed by removing a further portion of stomach and anastomosing the open end to the jejunum. Following operation she drained a small amount of biliary and pancreatic fluid for ten days and then this ceased spontaneously. A cholangiogram showed a patent anastomosis (Fig. IV). The "T-tube" was removed on the eighteenth post-operative day and she was discharged from hospital on the 11th January, 1957.

Progress after second operation: Since then she has remained well, and when last seen on the 1st April, 1959, she re-affirmed that she had suffered no abdominal pain or indigestion following her second operation, twenty-seven months previously.

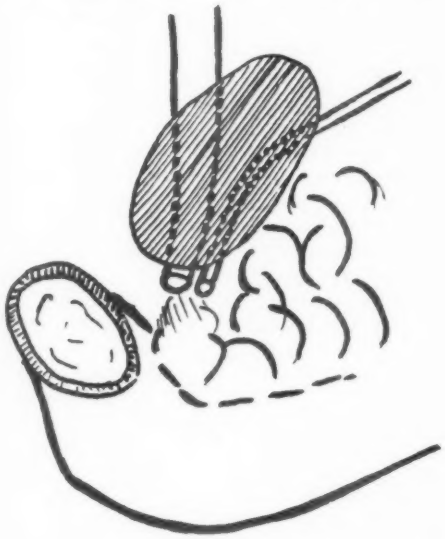

FIG. II. The injury sustained by the common bile duct and pancreatic duct.

DISCUSSION

Division of the two ducts just outside the duodenal wall is the result of carrying the dissection too far distally. In the case reported here emergency surgery was necessary on account of a bleeding anastomotic ulcer situated on the posterior aspect of a gastro-duodenal (Billroth 1) anastomosis. The lower edge of the ulcer was related intimately to the ducts and in endeavouring to obtain a fringe of duodenum for closure the ducts were divided. In each of the 3 cases reported by Carpenter and Crandell (1958) considerable scarring was present. This danger of injury to the ducts is one of the reasons why ulcers extending low down the duodenum are best not disturbed and the duodenum closed immediately above. This is not always possible and in the case reported here the severe haemorrhage necessitated an initial duodenotomy which led to partial detachment of the duodenum from the ulcer. To secure a sound closure of the duodenum this detachment was completed and with disastrous result. In retrospect it would have been best to have opened the common bile duct and passed a sound to identify the lower end.

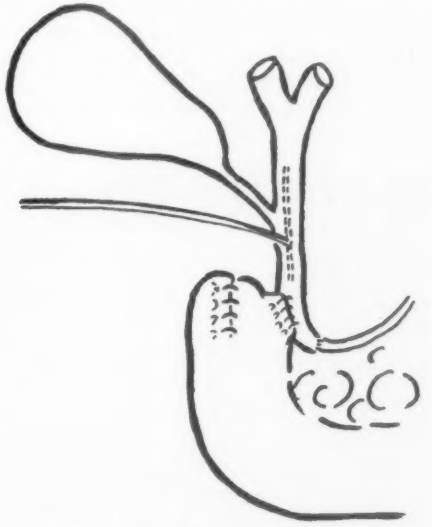

FIG. III. The reconstruction used.

The injury was not detected for some minutes because of temporary sealing of the open ends of the ducts. The first indication was the appearance of clear fluid from the pancreatic duct. In one of the cases reported by Carpenter and Crandell (1958) the distal orifices of the cut ducts were seen emerging through the serosal coat of the duodenum but the proximal ends were grasped in a pair of artery forceps and could easily have been ligatured.

Four methods of repair have been utilized in published reports.

1. Direct end-to-end anastomosis of the respective ducts. The first case reported by Carpenter and Crandell (1958) was treated by end-to-end anastomosis of the common bile duct over polythene tubing brought out

through an incision in the upper end of the common bile duct; the pancreatic duct was sutured over polythene tubing. This patient developed jaundice subsequently and although dying from leukaema nineteen months after operation autopsy showed a break-down in the anastomosis. End-to-end anastomosis was out of the question in the authors' patient because the distal segment was too narrow and in any case it was situated on the edge to be inverted for closure of the duodenum. Attention has been drawn to the abrupt narrowing of the intramural portion of the ducts (Hughes and Kernutt, 1954) and if the ducts were severed at the junction of the wide and narrow lumens end-to-end anastomosis (and suture) is impossible.

FIG. IV. Post-operative cholangiogram. The bile ducts are filled. The anastomosis between the lower end of the bile duct and the pancreatic duct is seen. There is a small amount of dye in the duodenum indicating that the choledocho-duodenostomy is functioning.

2. End-to-end anastomosis of the common bile duct and pancreatic duct. In one of the cases reported by Warren (1951) a partial gastrectomy was performed for a duodenal ulcer; the ulcer involved the common bile duct and a large pancreatic duct, regarded as the duct of Santorini. An opening was made in the common bile duct above the junction with the cystic duct and the long end of a "T-tube" was threaded through the severed end of the common duct into the pancreatic duct. The edges of the two ducts were approximated with fine silk and continuity with the gastro-intestinal tract was re-established with a cholecyst-jejunostomy. A temporary pancreatic fistula formed but this soon closed and eighteen months later the patient was well. In the authors' case the cut ends of the two ducts were sutured together, and the common duct was joined to the duodenal stump; a "T-tube" was inserted into the common bile duct but the end was not taken through the anastomosis. A fistula drained for a few days only, and two and a quarter years later the patient remains very well.

3. Implantation of the severed ducts into the duodenum. No instances of primary implantation of the ducts into the duodenum have been reported. In the authors' case the ends of the ducts were almost flush with the pancreatic parenchyma. It was felt that it would be difficult to secure a water-tight direct implantation into the duodenum. However, Warren (1951) reported two successful cases of delayed repair in which implantation into the duodenum was used. In one of these cases the pancreatic duct only was divided and this was anastomosed to the duodenum five months after the original operation. In the other five and a half months after the initial gastrectomy the two ducts were implanted separately into the duodenum. In a subsequent review (Warren, 1954) he records an additional case in which both ducts were divided; a cholecyst-jejunostomy prevented a biliary fistula but it was necessary at a later operation to implant the severed pancreatic duct into the duodenum.

4. Implantation of the ducts into the jejunum. Warren (1951) reported a case in which the ducts, injured during the course of gastrectomy for duodenal ulcer, were implanted into the proximal loop of jejunum. A subphrenic abscess complicated the convalescence but the subsequent functional result was good. In the second case of Crandell and Carpenter (1958) the open end of a Roux-Y segment of jejunum was anastomosed to the defect in the pancreas at the site of the cut ducts. This was followed by a satisfactory convalescence and three years later the patient was well. In their third patient a

Roux-Y segment was brought into the right hypochondrium; the common bile duct was divided above the panceras and implanted into the jejunum, and the pancreatic duct was placed separately below this anastomosis. Convalescence was slow but ten months later the patient was well.

The five cases reported by Warren (1951) recovered after surgery, although one had a subphrenic abscess. Each of the three cases treated by Carpenter and Crandell (1958) recovered but one was very ill post-operatively. Caudell, Lee and Lieberg (1958) refer to one case of theirs in which the injury occurred; it was recognized and a primary repair performed (no details given) but the patient subsequently died. It is unlikely that the occasional fatal cases would be reported in the literature so that it is not possible to estimate how often successful repairs are accomplished but it is probable that "The real tragedies incident to major pancreatic ductal injuries during gastric surgery derive from the failure to recognize and correct the traumas rather than from their irreparable character" (Warren, 1951).

SUMMARY

A case is reported in which during the course of emergency surgery for a bleeding anastomotic ulcer following a Billroth I gastrectomy (performed for duodenal ulcer), the lower ends of the bile and pancreatic ducts were severed. Repair was achieved by anastomosing the cut ends of the two ducts together, and the side of the common duct to the side of the duodenum. The convalescence was good and two and a quarter years later the patient is in excellent health.

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PROBLEMS IN THE MODERN PRACTICE OF HEAD INJURIES

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A STUDY of head injuries admitted to the Royal Melbourne Hospital in 1956 has been made and comprises the major part of this paper. The case histories of head injuries admitted in 1936 were also studied and the findings have been tabulated for comparison. Certain conclusions have been drawn.

If injuries to the facial skeleton alone are excluded, 131 patients were admitted to the Royal Melbourne Hospital in 1956 suffering from head injuries. Twenty-nine of these patients had other injuries of moderate or severe degree.

In 1936 the total admissions amounted to 236.

Incidence

The sex distribution was predominantly male and remained the same in the two series (Table 1).

The severity of the injuries is indicated in Table 2 which gives the incidence of associated injuries, of skull fracture and the type of fracture.

Table 1

	Total Admissions	*Male*	*Female*
1956	131	105	26
1936	236	188	48

A study of the case histories suggests that many more minor head injuries were admitted in 1936 than in 1956, but on the other hand, if one accepts a fracture of the skull as one of the criteria for admission to hospital, more moderately and severely injured patients were admitted in 1936. This is a surprising finding when related to the increase in population and the great increase in traffic density.

It would be comforting to conclude that road safety has increased, but it seems more probable that the change is due to a redistribution of accident cases through suburban and even country hospitals.

Incidence in relation to the day of the week and season of the year

In 1956 (as in 1936) more accidents occurred on Saturday than on any other day of the week (Table 3). The extent to which alcohol accentuates the dangers of week-end motoring is difficult to assess, but its presence is only too often evident in both pedestrian and driver patients.

Although monthly admissions in 1936 showed a definite upward trend during the summer months, this is not evident in the figures for 1956 (Table 4).

Mode of injury

At the hospital an attempt is made to determine the mode of injury in each case in order to correlate this with the probable nature of the pathological processes set in train.

Here considerable difficulties arise as many patients have amnesia for a period preceding

Table 2

	Head injuries only	*With assoc. major injuries*	*Fractured skull (Total)*	*Fractured skull (Closed)*	*Externally Compound fracture of vault*	*Internally compound fracture involving frontal sinus*
1956	102	29	85	60	13	12
1936	229	7	117	102	3	12

their accidents and others are too ill to question in the acute stage when their information could be valuable. Much of the responsibility for obtaining useful information falls upon busy Casualty staff who must usually rely on meagre details gleaned from police or ambulance personnel who have reached the scene some time after the accident and who often are unaware of the importance of precise information in diagnosis and prognosis.

In only 2.5 per cent. of cases in 1956 was the mode of injury not ascertained, whereas 14 per cent. of histories in 1936 contained no record.

TABLE 3

DAILY ADMISSIONS

	Mon.	*Tues.*	*Wed.*	*Thur.*	*Fri.*	*Sat.*	*Sun.*	*Unknown*	*Total*
1956	20	17	21	18	15	27	12	1	131
1936	27	28	23	30	30	55	43	—	236

In 1956 pedestrians were the worst sufferers, comprising 26.7 per cent. of the total head injuries (Table 5). Most of the victims were struck by motor cars.

An interesting feature was the high proportion of injuries due to falls, the majority being from a height and usually sustained at work. Most of the remaining falls were due to such everyday accidents as tripping over an obstacle or slipping on the proverbial banana skin. Falls down stairs and epileptic fits were other causes. Three of the four gunshot wounds were suicidal.

Other miscellaneous causes of head injuries were blows from falling bricks, an aeroplane propellor, a broken emery wheel and a rock following an explosion. A crush injury was due to the head being caught in a printing press which, fortunately was being moved only by hand. A fractured skull was sustained by a pedestrian who absentmindedly walked into a steel pipe protruding from a loaded truck.

Analysis of the 1936 figures shows a basically similar pattern but the life of a pedestrian seems to have been somewhat less hazardous than at present.

Mortality

In 1956, of 12 deaths within twenty-four hours of injury, 7 were pedestrians struck by motor vehicles. All were deeply comatose on admission, with signs of severe brain damage and 4 had multiple fractures in addition. One patient making an apparently good recovery from a suicidal bullet wound of the frontal region died on the tenth day from myocardial infarction. The remaining 2 were suffering from closed fractures of the skull and severe cerebral lacerations with extensive subdural haemorrhage. One was a Only one of these 12 patients, a case of compound depressed skull fracture, presented an indication for operation.

Subsequently 10 deaths occurred from the second to thirteenth days following injury, giving an overall mortality rate of 17 per cent. (Table 6). There was no predominant mode of injury in this group. Two deaths were due to associated injuries, viz. one was due to a ruptured liver and one to multiple fractures and shock. Respiratory complications accounted for five deaths. Three of these cases had associated major injuries.

TABLE 4

MONTHLY ADMISSIONS

	Jan.	*Feb.*	*Mar.*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Total*
1956	4	7	10	12	7	16	11	14	10	8	16	16	131
1936	30	15	23	26	14	13	11	19	13	16	31	25	236

chronic alcoholic and at autopsy was found to have gross cirrhosis of the liver.

Comparing the statistics for 1936 presented considerable difficulties, for whereas the series of patients in 1956 came under personal observation, assessment of the earlier series had necessarily to be made by a study of case histories which only too often lacked important information. It is impossible to indicate for 1936 any predominant mode of injury in the fatal cases, as the nature of the accident was frequently unknown. Autopsy reports were available in a few cases only.

Allowing for the admission of more minor head injuries in 1936, the mortality rate for that year is conservatively estimated to be 9 per cent. greater than for 1956 (although only 4 per cent. on gross figures — see Table 6). Comparison of the two series reveals some important reasons for this difference.

In the modern management of head injuries it is accepted that in some cases death is inevitable due to gross brain damage and is not likely to be much delayed beyond twenty-four hours. The presence of other injuries or medical disease worsens the prognosis. It is considered that patients surviving this period have good prospects of recovery. In many of this group survival is dependent on the prevention of complications, close observation for signs of developing complications, and prompt treatment should they appear.

Complications

Respiratory embarrassment and hyperpyrexia were found to be amongst the earliest complications of severe head injuries in this series. Hyperpyrexia increases the oxygen demands of the damaged brain which is particularly vulnerable to a lowering of oxygen tension. Its onset is often rapid and only too apt to be unnoticed until established at a high level when a fatal outcome is almost certain.

The adoption of routine rectal temperature estimation if the axillary temperature exceeds 101°F and the almost automatic institution of cooling methods by the ward nursing staff has vastly reduced the frequency of this complication. Adequate hydration is important in its prevention and treatment and is prone to be neglected in unconscious patients due to a fear of aggravating raised intracranial pressure.

TABLE 5

MODE OF INJURY

	1956		1936	
	No.	*Percentage*	*No.*	*Percentage*
Pedestrians struck by vehicles	35	26.7	48	20.4
Vehicular collisions	22	16.8	48	20.4
Vehicular collisions with stationary objects	10	7.7	11	4.7
Falls from moving vehicles	14	10.7	32	13.4
Falls (a) from a height	14	20.6	20	14.8
(b) not from a height	13		15	
Falls from horses	—	—	5	2.2
Assault	8	6	12	5.1
Gunshot wounds	4	3	2	0.8
Miscellaneous	8	6	9	4
Unknown	3	2.5	34	14.2
	131	100	236	100

TABLE 6

	No.	*Percentage*
Mortality in first twenty-four hours—		
1956	12	9
1936	28	12
Mortality after twenty-four hours—		
1956	10	8
1936	22	9
Total Deaths		
1956	22	17
1936	50	21

Prolonged partial respiratory obstruction due to pooling of blood or secretions in the pharynx, with depression of the cough reflex, or to anatomical factors also exacerbates brain damage and respiratory infection soon supervenes to act as a further detriment to recovery. The unhesitating performance of tracheotomy has largely overcome this problem and it has thus become a very valuable procedure in combating serious chest infections.

Apart from tracheotomy (11 patients) and operations for associated injuries, 42 patients in the series of 131 underwent surgery.

The above figures indicate the change brought about in the management of head injuries in the years since World War II and this is no doubt due to the introduction of modern neurosurgical principles in the treatment of head injuries and a better understanding of the underlying pathology.

TABLE 7

OPERATIONS

Type of Operation	1956		1936	
	No.	*Mortality*	*No.*	*Mortality*
Exploratory craniotomy	6		1	
Evacuation of subdural haematoma	10	2	2	1
Evacuation of extradural haematoma	4			
Evacuation of subdural hygroma	1			
Elevation of depressed fracture	7		4	
Debridement of compound fracture	3	1	2	1
Cranioplasty	1			
Fascia lata graft to frontal sinus	5			
Decompression of optic nerve	2			
Plastic repair of scalp defect	2		1	
Section of auditory nerve for post-traumatic tinnitus	1			
Subtemporal decompression			2	2
	42	3	12	4

All of the patients requiring tracheotomy in 1956 were gravely ill, but there were several survivors. It is interesting to note that in 1936 no tracheotomy was performed and that no patients with severe head injuries and a prolonged period of unconsciousness survived. Four of these died in a state of hyperpyrexia within two to four days of admission, there being no evidence of the institution of any cooling measures. There were no deaths in 1956 attributable to hyperpyrexia.

The role of antibiotics in lowering the present-day mortality in head injuries is probably a very minor one, for meningitis (due to a haemolytic streptococcus) was responsible for only one death in 1936 and they are of little avail in chest infections where there is pooling of bronchial secretions.

Operations

In seeking other causes for the better survival rate today, a great increase is noted in operations performed during 1956, in comparison with the few in 1936 on a considerably larger group of patients (Table 7).

There were three post-operative deaths in 1956:

(a) A car driver, aged 61 years, who had been drinking, was admitted comatose with a compound depressed fracture of the frontal bone and severe generalized brain damage sustained when his car collided with the rear of a semi-trailer. He failed to improve after decompression and debridement and died within twenty-four hours.

(b) A chronic alcoholic, aged 56 years, with a history of epilepsy for several months, was admitted stuporose after striking his head on the pavement during a fit. He soon regained consciousness but ten hours later rapidly became comatose with lateralizing signs. Immediate craniotomy revealed a lacerated right temporal lobe with acute subdural and intracerebral haematomata. Haemostasis was difficult due to generalized oozing. He failed to improve and five days later was re-explored when only a small collection of blood was found. Death occurred ten days after admission. Autopsy revealed a fissure fracture through the base of the middle fossa, a subdural collection of blood at the base of the skull and gross cirrhosis of the liver.

(c) An 18-stone man, aged 48 years, known to be hypertensive, was admitted stuporose after falling from a moving truck. There were scalp injuries in the right parietal and left occipital regions. Both plantar reflexes were abnormal and his blood pres-

sure was 210/130 mm. of mercury. No definite fracture was seen radiologically. After slowly improving for five days he suddenly deteriorated, becoming comatose with signs of a left-sided lesion. At craniotomy a large left temporal subdural haematoma was evacuated. Improvement was only slight and tracheotomy was performed because of chest infection. Four days later, hyperpyrexia to 105°F developed and was controlled with difficulty. Re-exploration of both sides revealed no further clot. Death occurred twelve days after admission. Autopsy showed a long fissure fracture in the right occiput and middle fossa and gross tearing of the brain in the left temporo-sphenoidal region and both frontal lobes.

The remainder of the patients undergoing operation recovered satisfactorily except for one man who developed a staphylococcal infection of a subdural haematoma associated with severe brain damage. This responded to repeated drainage and chemotherapy.

TABLE 8

	1956	1936
TOTAL PATIENTS	15	6
Intellectual impairment	5	2
Visual defect	3	1
Ocular palsy	3	1
Facial palsy	1	—
Monoparesis	1	—
Hemiparesis	2	—
Sensory defect	—	1
Anosmia	5	—
Dysphasia	3	—
Tinnitus	1	—
Epilepsy	1	—
TOTAL NEUROLOGICAL DEFECTS	25	5

Morbidity

In the surviving 109 patients in 1956 there was little gross permanent morbidity. The main complaints were headaches, lassitude and lack of concentration which usually disappeared in a few weeks. Epilepsy occurred in a number of cases but usually did not persist beyond the acute stage.

In 3 cases intellect appeared to be permanently seriously impaired and there was one of moderate and one of minor impairment. There are good prospects for the rehabilitation of the latter two but the others will probably require permanent institutional or family care.

At the conclusion of the period of review, 25 neurological defects were observed in 15 patients (Table 8). The small figures for 1936 reflect the failure to survive of patients with severe head injuries.

The case of tinnitus followed mild concussion in a motor accident, no fracture being detected. The persistent loud ringing in one ear over a period of three months drove the victim to attempted suicide. Section of the appropriate auditory nerve almost completely eliminated the tinnitus and restored peace of mind.

The higher survival rate with modern treatment has resulted in a greater number of medical and social problems. However, this should be no deterrent to doing the utmost to save the lives of apparently hopeless cases. In the early phases it is often impossible to predict the outcome of a head injury and sometimes astonishing recoveries occur, especially in young persons. Therefore the management of head injuries must be directed towards the prevention and treatment of any complications which may jeopardize the patient's life or increase morbidity with its resultant social problems.

In this mechanized age of ever-increasing speed, the closed head injury with generalized brain damage has become a common problem. To illustrate some of the medical, nursing and social problems associated with such injuries, three of the most severe cases are described below. It will be seen that from an essentially similar beginning there was a variable degree of recovery which, in one case, will lead to a practically normal life and, in another, to at least quite a useful life. The greatest recovery occurred in Case 3, a boy aged 14 years.

Case 1

A.P., a pedestrian aged 38 years, was admitted deeply comatose on 20th April, 1956, a few minutes after being struck by a car.

Examination: B.P. 12/80. Pulse 92. Respirations stertorous and mildly obstructed.

Bilateral peri-orbital haematomata, and lacerations of tongue and scalp over vertex.

Inward deviation of left eye, with smaller pupil than on right, and sluggish reaction of both pupils. Complete flaccid paralysis with no reflexes.

X-rays of skull showed extensive fissure fractures on the right side involving parietal, temporal and frontal bones, greater wing of sphenoid and middle fossa.

Generalized extensor spasticity, more marked on the right side, developed over the next few days. He remained comatose and on the fifth day respiratory difficulty and chest infection necessitated tracheotomy. Hyperthermia also developed but was controlled by vigorous cooling measures.

On the seventh day temporal and posterior burr holes were made, but revealed only a thin subdural collection of blood on the right side and a small posterior subdural haematoma which was evacuated. Ventriculography showed an abnormally wide third ventricle.

Three weeks after admission he was responding to his name and had regained fair movement of the left side. A right hemiplegia persisted and lesions of the right sixth to eleventh cranial nerves were evident.

Prolonged intravenous feeding had been necessary because of regurgitation after tube feeding.

After four weeks he was obeying a few simple commands.

Another ventriculogram showed moderate symmetrical dilatation of the ventricular system, indicating some degree of cerebral atrophy.

A further left temporal burr hole showed only a thin film of clear subdural fluid.

In the fifth week attempts to speak were made and movements of the right leg commenced.

Gastrostomy was performed because of constant feeding difficulties, regurgitation and vomiting being frequent. Chest infection was also troublesome. Anaemia was corrected by blood transfusion.

In the seventh week the tracheotomy tube was permanently removed. Subsequent chest infection was controlled by chemotherapy and posturing.

Two months after admission his cranial nerve lesions and a right hemiparesis were still present. Speech, in a peculiar "nasal" voice, was improving and he seemed to understand orders. However, there appeared to be a complete loss of balance, with inability to hold up his head. There was profound loss of all higher intellects and for several weeks he was very restless, unco-operative and destructive.

However, improvement in intellect, memory, speech and walking was apparent from the third to six months and he began to take an interest in reading. His gastrostomy was allowed to close.

Six months after admission he was transferred to the Austin Hospital. He still had an almost complete right hemiplegia, with inability to walk without assistance and his pharyngeal and palatal paralyses persisted.

Subsequent improvement enabled transfer, after a further six months, to a Benevolent Home, where an intensive rehabilitation course of speech and occupational therapy and physiotherapy is still producing improvement, so that nearly two years after his injury this patient has an almost full range of movement. Mentally he is alert and well orientated in time and place, and can converse simply in his now not so "nasal" voice. He reads well and spends weekends at home with his family, being quite co-operative and amenable to reason. Further improvement is anticipated.

Case 2

K.B., aged 30 years, was admitted from the country on 24th June, 1956, thirty hours after being struck by a car whilst riding a bicycle. He had been comatose for three hours after the accident, then in a restless state of "cerebral irritation" for a further five hours, followed by slowly deepening coma and diminishing movement of the right side.

Examination: Comatose; response to painful stimuli. Coughing and swallowing reflexes present. Pulse rate 120, respirations 20, B.P. 140/90. Right parietal haematoma of scalp. Eyes deviated to right side. Right pupil slightly larger. Both reacted briskly to light. Generalized hypertonicity, more marked on right. Bilateral extensor plantar reflexes.

X-ray of skull: Vertical fissure fracture of left parietal bone posteriorly.

Exploratory burr holes soon after admission revealed no significant findings on the right side. On the left side a posterior burr hole revealed a small extradural clot and the dura was seen to be stripped away from the skull for a considerable distance. A thin layer of subdural clot was also present.

A moderate amount of subdural clot was evacuated through a left mid-temporal burr hole. The cerebral cortex here and in the adjacent parietal region, was severely contused.

He remained deeply comatose for nine days, with variable periods of extensor rigidity, often provoked by nursing procedures, but tracheotomy was not necessary. There was movement of all limbs except the right arm. After initial intravenous therapy to improve hydration, feeding was by stomach tube. The prognosis appeared gloomy.

However, the day after a normal ventriculogram on the ninth day, a definite improvement was first noted. This progressed slowly and two weeks after admission he was responding to his name. There was good movement of the left limbs, but a marked right hemiplegia. By three weeks he was conscious and taking food orally, but was still confused and did not recognize his relatives. He was also incontinent of urine and grossly dysphasic.

He now began sitting out of bed and with physiotherapy and speech therapy improved considerably. Six weeks after admission he had a residual right hemiparesis, affecting particularly the arm, but was walking well and speaking intelligibly despite moderate dysphasia. There was no urinary incontinence. Intellectual function, although impaired, was quite good, but there was lack of insight. He was able to discuss intelligently plans for his convalescence. By this time he was a useful and cheerful "handyman" around the ward.

He was discharged to the care of friends for whom he did light work in a shearing shed (previous occupation — minister of religion).

Three months later he had only a mild paresis of the right arm, and his speech had improved considerably although dysphasia was still present. Lack of insight persisted but he appeared to be a reasonably happy and intelligent person.

Eighteen months after his injury, following a further rehabilitation course, there is very little residual physical disability, but there is still doubt whether it will be possible for him to resume his former occupation because of blunting of intellect and impaired insight and foresight.

Case 3

R.L., aged 14 years, was admitted on 1st September, 1956, half an hour after being knocked from his bicycle by a car. His trunk was then run over by a second car.

Examination: Unconscious, moaning, restless. Pulse 100, respirations 22, B.P. 140/100. Lacerations of scalp behind right ear and in left parietal area. Pupils equal and reacted to light. Generalized extensor rigidity; no reflexes. Deformity in lumbar region.

X-ray of skull: no fracture detected.

X-ray of spine: Traumatic spondylolisthesis with nearly an inch displacement of L.5 on S.1. Appearance suggested aggravation of a long-standing abnormality.

Four hours later the onset of hyperthermia (105.5°F) peripheral circulatory failure and Cheyne-Stokes respirations necessitated urgent cooling measures and blood transfusion. He improved, but remained extremely ill, with frequent spasms of extensor rigidity. For several days chlorpromazine 25 milligrammes intramuscularly was given two-hourly to reduce his temperature and extensor spasms. Tracheotomy was necessary on the fourth day because of chest infection.

Posterior burr holes on the sixth day showed an oedematous brain with a low intracranial pressure. No space-occupying lesion was revealed by ventriculography.

After two weeks the conscious state and extensor spasticity had improved a little, but the prognosis appeared very poor. Chest and urinary tract infections and pyrexia were troublesome.

As further improvement occurred over the next week, a severe cauda equina lesion became evident, with paraparesis and incontinence of faeces and urine. Daily physiotherapy was commenced at an early stage. He improved considerably during the fourth week when he began drinking fluids and attempting to speak. He now responded to simple orders. The tracheotomy tube was removed.

By the end of the fifth week he was fully conscious and reading and talking well, but remained mentally confused and was often noisy and irritable, requiring heavy sedation. Attempts to reduce the spondylolisthesis were unsuccessful.

After three months his mental state had greatly improved but he was still irritable and noisy at times, incontinent of urine and required regular enemata.

Further gradual improvement occurred and six months after his injury he appeared to be an alert boy of almost average intelligence for his age, with little mental or physical defect attributable to his brain injury. He took an active interest in reading and occupational therapy, and had a good memory for all events preceding his accident. He had no memory for six weeks following this, but a good memory for subsequent events.

Unfortunately his cauda equina lesion did not improve comparably, although he was now able to stand. Bladder and bowel paralysis persisted. A decompression laminectomy made no appreciable difference.

However, a year after his injury he was able to walk resonably well and control his defaecation and micturition, the latter being aided largely by manual compression of the bladder.

These case histories are illustrative of the modern problem of the surviving severe head injury, whose increasing numbers parallel the growth of high-speed transport and the skill of modern surgery and nursing.

The prime aim in treatment is to restore the patient to a useful position in the community. This is usually a matter of many months and highlights the urgent need for a metropolitan rehabilitation centre — even greater than that of a spinal injuries centre, for many patients need re-education of both mind and body which can only be satisfactorily supplied in a properly equipped centre with specially trained staff.

Placement in suitable jobs is a major problem and could be considerably lessened by liaison between such a centre and industry where there is considerable prejudice against employment of persons known to have suffered head injuries. Considerable social adjustment is often necessary, for a skilled person may be reduced to the necessity for earning a living by unskilled labour. This, naturally, closely affects his family, and is the subject of litigation in many such cases.

DISCUSSION

1. Fewer patients with head injuries are now being admitted than twenty years ago. The main factors responsible for this are—
   (a) Many patients with minor injuries who would have been admitted twenty years ago, are not admitted today because of the acute bed shortage.
   (b) There has been an increase of metropolitan hospital beds.

2. As in 1936, more head injuries occur now on Saturday than on any other day.

3. The role of alcohol in a large proportion of head injuries is obvious, but no accurate assessment has been attempted.

4. The commonest patient with head injury now (26.7 per cent.) as in 1936 (20.4 per cent.) is the pedestrian struck by a car.

5. In recent years there has developed a much greater appreciation of the value of an accurate history of the mode of a head injury in diagnosis and prognosis, but there is still room for further education of medical and ambulance staff and police.

6. There has also developed a much greater awareness of the need and value of operative intervention in many cases. This is reflected by the improved survival figures compared with those of twenty years ago.

7. Parallel with (6) has been the increasing use of tracheotomy to combat respiratory obstruction and chest infection, and the prevention and prompt treatment of hyperpyrexia.

8. Improved methods of treatment have led to the survival of a number of patients with severe head injuries who would almost certainly have died if admitted with the same injuries twenty years ago. This has naturally led to more social and rehabilitation problems, but the fact that some patients have been restored to a virtually normal life fully justifies the most vigorous attempts at salvage.

9. The first principle of treatment is prophylaxis, and it is certain that many lives could be saved by the introduction of more stringent safety precautions in motor vehicles, e.g. crash helmets for motor cyclists, safety belts and padded dashboards in cars. The large number of injuries due to falling from building construction jobs suggests that there may well be room for improved safety methods in the building industry.

SUMMARY

A survey and comparison of head injuries admitted to the Royal Melbourne Hospital in 1956 and 1936 have been made. There are similarities in the nature and severity of the injuries.

Marked differences occur in the surgical management of the two groups, indicating that considerable advances have been made in management of cranio-cerebral trauma in the past twenty years.

ACKNOWLEDGEMENTS

Due acknowledgement is made to the Honorary Medical Staff of the Royal Melbourne Hospital for permission to publish case records. My thanks are due to Mr. R. S. Hooper for his encouragement and helpful criticism in preparing this paper.

ILEAL PERFORATION DURING CORTISONE THERAPY

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THE ulcer provoking properties of cortisone are now well known, and although a recent paper by Goldgraber *et alii* (1958) challenges this, the consensus of clinical opinion remains that cortisone can cause or activate ulcerative disease in the colon and stomach (Halsted *et alii*, 1954; Tulin *et alii*, 1952). This paper presents a case of ileal ulceration and perforation occurring in a patient on long-term cortisone therapy.

Case history

Mr. E. was aged 45 years when he first presented to the Royal Adelaide Hospital on 14th December, 1955, with iridocyclitis, scleritis and episcleritis which had been present for three months. This recurred several times during the next twelve months. He then developed fever, pain and swelling in both legs, worse on the left side and had several rigors. There was no definite evidence of deep vein thrombosis but there was a transient rash resembling erythema multiforme on the legs. He also developed severe pain in the right side of the chest.

At this stage he was admitted to hospital where he was found to have an E.S.R. of 90 mm., 1st hour reading and 129 mm., 2nd hour reading, and a persistent leucocytosis in the region of 15,000 white blood cells of which 70 to 80 per cent. were polymorphonuclear. Chest X-ray, E.C.G., Widal, Brucella and Proteus OX.19 agglutinations and blood cultures were normal. The electrophoretic pattern of serum proteins revealed a low serum albumin (2.47 gm. per cent.) and a raised alpha 2 globulin up to 1.21 gm. per cent. The gamma globulin, however, was normal. Pectoral muscle biopsy and skin biopsy were negative for polyarteritis nodosa. The patient also developed intermittent attacks of severe cramp-like abdominal pain in the region of the umbilicus, and with these attacks he vomited. Steroid therapy was begun fourteen days after the patient's admission to hospital, and in the succeeding six weeks the E.S.R. gradually fell, the attacks of pain became less frequent and the white cell count fell.

He was discharged and treated as an outpatient having 40 mg. of Delta Cortef daily, his main disability being discomfort from swelling of the left leg and intermittent attacks of abdominal discomfort. By October, 1957, the E.S.R. and electrophoretic pattern were normal, and steroid therapy was discontinued.

He later developed a chronic ulcer on the left ankle, and his weight increased considerably, but he was otherwise well and the E.S.R. remained normal until September, 1958, when he complained that he again felt unwell and that he had further chest pain resembling that which had preceded his earlier acute illness. He began to lose weight rapidly, losing some 35 lbs. in two months and the E.S.R. rose to 55 mm., 1st hour reading, 84 mm., 2nd hour reading. In view of this steroids were recommenced as Medrol 5 mg. daily and increased to 20 mg. daily.

Although this produced temporary improvement, attacks of severe abdominal pains and vomiting continued and the patient was re-admitted to hospital. In hospital he continued to lose weight, and most investigations, including biopsy of the superficial veins, barium meal, serum amylase, revealed no further information. Finally, after a particularly severe attack of abdominal pain, the patient did not recover as he had previously, and was discovered to have signs of generalized peritonitis.

Laparotomy showed general plastic peritonitis with a large amount of free pus. In the terminal ileal loop there was a haemorrhagic oedematous plaque about 3 cms. in length with a perforation 2 mm. in diameter in the antimesenteric border. About 10 cms. distal to this was a small puckered area with fine vessels running over it. This was thought to be another superficial ulcer. No other lesions were seen in the small bowel, or the right colon. This area was resected and end-to-end anastamosis performed. The patient made a surprisingly uneventful recovery from this. There was mild wound infection, but little delay in healing. The steroid was gradually reduced. He was discharged home on 5 mgm. of Medrol alternate days.

Pathology of specimen (Dr. E. G. Hardy)

Macroscopically

A small ulcer in the position marked. There is another area of ulceration of the mucosa 3 cm. in diameter with surrounding oedema and thickening.

Microscopically

The mucosal surface is ulcerated and the base of the ulcer is covered with a thin layer of fibrinous exudate and polymorphonuclear leucocytes. The submucosa which is infiltrated with polymorphonuclear leucocytes, lymphocytes, a few plasma cells and eosinophils, is oedematous, vascular and haemorrhagic. There is no scarring and only a little granulation tissue has been formed. The serosa is haemorrhagic and covered with purulent exudate. There is no evidence of polyarteritis or malignancy and the microscopic findings are those of non-specific ulceration of recent origin.

Discussion

It is apparent that the problem of this patient's diagnosis remains during any discussion of the aetiology of his intestinal

ulceration and perforation. Intestinal perforation is a well-recognized presentation and complication of peri-arteritis nodosa. Recent case report and reviews by Pugh and Stringer (1957) indicate clearly that this is associated with recognizable histological changes in the intestinal and mesenteric vessels. Specimen in this case was examined carefully with this in mind and complete absence of peri-arterial cuffing reported.

Another described ulcerative condition of the ileum which this lesion imitates, is the so-called "simple ulcer" of the intestine. This is an uncommon but a well-documented condition described first in 1805 by Matthew Baillie. Most recent case report and reviews is by Gerald Keen (1958). Histologically this lesion is characterized by acute or chronic inflammation with reaction of varying degree. Etiology is unknown, but trauma, thrombosis, stress and bacterial infection have all been postulated. To this I propose to add cortisone. Review of the current literature reveals few similar case reports of small bowel perforation associated with cortisone, but unassociated with previous intestinal lesion. These have been mainly in patients with rheumatoid arthritis and in whom generalized arteritis has occurred. Parker and Thomas discuss these cases in a recent case report (1959).

This is of course not necessarily indicative of its frequency and it is hoped that this paper will provoke further opinions on this subject. The method by which cortisone could produce such ulceration is of course purely speculative, but in view of its well-known action in suppressing the acute inflammatory response, and its effect on intercellular cement substance it seems reasonable that any mucosal breach of the intestine could soon lead to ulceration and perforation.

SUMMARY

A case of ileal perforation in a patient treated with prolonged cortisone therapy is presented. It is suggested that the association is more than coincidental and that the apparent rarity of such perforations is due to absence of reports rather than absence of cases.

ACKNOWLEDGEMENTS

I am grateful to Professor H. N. Robson for permission to publish this case and to Professor R. P. Jepson for helpful advice and criticism.

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Books Reviewed

SURGERY FOR DENTAL STUDENTS.

By R. J. JEPSON and B. N. CATCHPOLE. Liverpool: English Universities Press Ltd., 1959. 8¾" x 5½", x plus 166 pp., 53 illustrations. Price: 39s. 3d.

This small volume purports to introduce to dental students the principles of general surgery and their particular application to dental practice. In this it is singularly successful. The bias of description and discussion is towards conditions of the head and neck and there is sufficient mention of the special diseases of ear, nose and throat to enable the dental student to appreciate these specialties as he should.

The authors have apparently not hesitated to draw freely from authoritative publications on oral pathology although no references have been quoted. Perhaps this is deliberate in order to simplify the text for students.

The general arrangement and printing are good and the illustrations, although restricted to black and white, are adequate. The book can be confidently recommended as a text for dental undergraduate teaching.

A SYNOPSIS OF ANAESTHESIA.

By J. ALFRED LEE. Fouth Edition. Bristol, England: John Wright & Sons Ltd., 1959. 7¼" x 4¾", 616 pp., 69 illustrations. Price: 27s. 6d. (stg.).

The popularity of this book with all candidates for senior anaesthetic qualifications is easily understood. A careful study of this edition shows that there is scarcely a page which does not show evidence of revision. New material has been added to bring the text as up to the minute as is possible with any publication.

It is usual for teachers to condemn books which fall under the heading of synopsis, and this book is no exception. However, it is surprising to find how many of these teachers use it as their standard reference when a dispute arises.

Any student facing an examination in anaesthesia in the near future would find it difficult to revise his work more easily than by a careful study of this volume.

DIFFUSE LESIONS OF THE STOMACH.

By I. J. WOOD and L. I. TAFT. London: Edward Arnold (Publishers) Ltd., 1958. 8¾" x 5½", x plus 86 pp., 35 figures. Price: 24s. (stg.).

This fascinating monograph gives a complete account of all that has been discovered by the use of the flexible gastric biopsy tube since it was first conceived by Ian Wood in 1948. All this work has been carried out in the Clinical Research Unit of the Royal Melbourne Hospital and Walter and Eliza Hall Institute. Following the introduction of this flexible biopsy tube, workers in gastro-enterology all over the world have adopted it enthusiastically.

It is gratifying to see such original work being carried out in Australia and it shows what progress is being made in medicine here. This volume is largely a consolidation of the many papers from the Clinical Research Unit on this subject published in Australia, Britain and the United States of America. It may be said to be final synthesis of a tremendous amount of work carried out by many members of this Unit over the ten-year period.

Gastritis has always been a difficult disease to understand and to diagnose. The ideas put forward here do a lot to clarify past uncertainties and misconceptions. Not everyone will agree that chronic superficial gastritis is quite such a clear-cut entity as the authors describe. One is left with the impression that the differentiation from nervous dyspepsia is not as easy as the biopsy tube seems to indicate.

The biopsy specimens are beautifully reproduced and it is a pleasure to see such clear photomicrographs. Those of us who know the Clinical Research Unit will not be surprised as this is typical of the standard of work produced there.

This is a book that must be read by all physicians interested in gastro-enterology. It should be read by all physicians and surgeons as there is much that is stimulating and of interest to all. It is thoroughly recommended.

BRAIN MEMORY LEARNING; A NEUROLOGIST'S VIEW.

By W. RITCHIE RUSSELL. Oxford: Clarendon Press, 1959. 8¾" x 5½", viii plus 140 pp., 12 illustrations. Price: 33s. 6d. (Aust.).

This is an approach to the mind-body relationship and attempts to explain certain faculties of the conscious and unconscious mind which underlie human awareness and behaviour. For this the author is well equipped, through careful observation of disturbances of consciousness in organic nervous disease. As one of his main interests has been cerebral trauma he uses his studies in this field to illustrate the review. This carries one disadvantage in that it is difficult to determine the extent of the damage even if the point of impact is known.

The early chapters give a useful survey of the anatomical and physiological processes which may underlie the phenomena of learned actions — and probably of memory. He remarks that "The probable importance of tonic normal activity coupled with the altered conditions of intracellular transmission to which it may give rise . . . is the central theme of the present book."

An interesting survey of the synapse and the role of the pre-synaptic impulse in facilitation follows, with its relationship to memory and the attendant feeling of familiarity. Naturally to a neurologist the hippocampal system is considered significant in this regard.

The central chapters consider problems of disturbance of consciousness in cerebral trauma such as concussion, retrograde amnesia, dementia and epilepsy. In this there is much to interest the clinician. The consideration of pain is particularly valuable, and here the author's wide clinical experience and capacity for reflexion on the usual as well as the unusual is emphasized.

Finally the author surveys the frontal area, with its thalamic and hypothalamic connections. In it he finds a mechanism for final judgement comparable to the psycho-analysts "super ego." Without

its emotional drive in childhood the intellect is unlikely to develop; and in adult life if it is disturbed as in leucotomy, the finer aspects of conduct may be sacrificed making the patient less acceptable to his fellows.

This is a stimulating study of the systems which regulate consciousness, which the author postulates to arise in the 10,000 million cells which comprise a single human central nervous system. Although some of it is tentative, and all will not be in agreement, it is the product of much thought and a well-stocked mind. It is his opinion that right training in early childhood can develop not only satisfactory and useful behaviour, but the intellect itself. Here the author urges the encouragement of research in this field.

This informative book could be read with advantage by many physicians and surgeons who practice in other fields than neurology.

ORTHOPAEDIC NURSING.

By MARY POWELL, S.R.N., M.C.S.P. Third Edition. Edinburgh and London: E. and S. Livingstone Ltd., 1959. 8¼" x 5½", xii plus 464 pp., 579 figures. Price: 27s. 6d. (stg.).

That a third edition of this book has appeared so soon after the second is surely the best possible testimonial to its excellence. There are but two major changes, and since both are contributed by acknowledged experts they are welcome additions to the next.

The first concerns the Thomas splint from the pen of Professor Bryan McFarland, who will visit this country this year. It is short, concise and to the point, and coming as it does from the acknowledged leader of the Liverpool School of orthopaedics it is as expected the last word on the subject. It could be read with advantage by anyone concerned in the management of fractures of the shaft of the femur.

The second addition is a chapter entitled "Orthopaedic Theatre Technique," by Miss Munt, whose fame as Theatre Superintendent at the Nuffield Orthopaedic Centre, has spread far beyond the precincts of Oxford. One wishes it could be closely studied by Theatre Sisters throughout this country if for no other reason than that many orthopaedic surgeons would, in consequence, sleep more soundly. And to whom it may concern we quote "it is generally thought *sufficient* to give each patient a shave and bath the day before operation followed by one skin preparation of . . . (or whatever antiseptic the particular surgeon prefers) the limb being covered by sterile towels bandaged on firmly. Then a further skin preparation is performed the morning of the operation. Once in the theatre the sterile towels are removed and a third skin preparation is performed . . .)."

There are other minor changes such as mention of Dupuytrens contracture, trigger finger and thumb. But why bring up the subject of moulded duralumin gutter-splints in the management of Colles' fractures — surely that is putting back the clock.

Once again we offer our sincere congratulations to Miss Powell for what has now become the standard work on orthopaedic nursing.

UROLOGY IN OUTLINE.

By T. L. CHAPMAN. Edinburgh and London: E. and S. Livingstone Ltd., 1959. 9" x 6½", vii plus 175 pp., 138 figures. Price: 27s. 6d. (stg.).

The most important prerequisite for an author is to have not only a good theoretical, but an excellent practical knowledge of his subject, and T. L. Chapman shows in this book that he has both.

The book itself contains an illuminating series of condensed material shown clearly and unmistakably with the accurate diagrams that he presents. These diagrams further show the practical knowledge of urology by the true life representation of disease appearances and defects. To the undergraduate and post-graduate student the book is invaluable, as it clearly shows the important causes on small condensed diagrams.

In the space devoted to each particular subject such as tuberculous infection, calculus disease, etc., he gives conflicting views quickly and sharply and has quoted widely from the literature.

There are some extremely important factors, which he stresses, particularly with relation to urinary output and intake; and also the particular reference that he makes to frequency of urine and the dangers that he points out with regard to this symptom as a diagnosis of obstructive disease at the bladder neck.

The book although small and short is surprisingly detailed. There are one or two minor omissions. In the special methods of urology, he makes no mention of cysto-urethrography. In renal calculus disease, there is not a very accurate summary of the conservative management of renal stone and the medical management post-operatively to prevent recurrence.

The material in the book is extremely well presented, and is a credit to the author. It is a valuable addition for the library of the undergraduate and post-graduate student and it is particularly important to the junior urologist in his application of specialized thinking and technique to the wide field of urology in general.

ANATOMY FOR STUDENTS OF DENTISTRY

By JAMES HENDERSON SCOTT,, D.Sc., M.D., L.D.S., and ANDREW DERART DIXON, M.D.S., B.Sc., Ph.D., Edinburgh and London: E. and S. Livingstone Ltd., 1959. 8¼" x 5½", xi plus 484 pp., 288 illustrations. Price: 55s. (stg.).

All dental students would welcome the publication of a satisfactory shorter textbook of anatomy designed for their particular demands. The book under consideration is meant to satisfy the needs of such students and it is expected that it will be used in conjunction with the "Introduction to Dental Anatomy" of Scott and Symonds.

In many respects the book is admirable. The text is kept within a desirable length while giving adequate coverage to most of the essential subject matter. It is considered, however, that the diaphragm should have been described more completely.

The student is introduced to many histological terms so early that he may be confused. Throughout the book histological sections are placed close to the relevant gross anatomy. This has advantages, but insufficient detail is provided to allow this book to substitute for standard histological texts.

The line illustrations are clear and lose nothing by the omission of colour, but Fig. 24b would be improved if the same bone had been used for the several views shown. The illustrations of the posterior abdominal wall (Figs. 61, 62) fail to include psoas major as a posterior relation of the kidneys. The osteological section is adequate when read by a person familiar with the subject matter, but some structures mentioned in the text are not indicated on the appropriate illustrations. Some bones are illustrated by photographs which sometimes lack clarity and occasionally the labelling is defective (Figs. 26, 28).

Excellent sections dealing with growth, development and the nervous system have been included and the authors should be commended for the repetition of some diagrams without captions to aid revision.

AN ATLAS OF SURGERY.

By F. WILSON HARLOW, M.B., B.S., F.R.C.S. London: William Heinemann, 1958. 13" x 8", 378 pp., 1,292 illustrations.

This is intended as a pictorial *aide-memoire* supplement to standard textbooks.

This book fails in many respects as it attempts too much. For instance perforated peptic ulcer is dealt with in three diagrams, one of gas under the diaphragm, one of omental overlay in sutures, and one operative specimen. Acute appendicitis merits five pictures, none with any great merit; acute pancreatitis one picture; portal hypertension one figure of oesophageal varices in a barium swallow; ulcerative colitis two figures, and carcinoma of the rectum four figures, with an additional two figures of theatre technique. Surgical shock and adrenalectomy receive one figure each, but diagrams of instruments, knots, oxygen apparatus and anaesthetic equipment are dotted throughout the book.

Although many of the diagrams are good, the book contains far too many subjects for any one to receive more than passing mention.

The whole arrangement and treatment is in the manner of an instrument catalogue. It lacks dignity of production, and although Sir Cecil Wakeley does write a foreword of praise it is hard to see what useful addition to surgical knowledge or instruction this book makes, for surgeon, house surgeon or student.

YEAR BOOK OF CANCER.

Edited by R. L. CLARK and R. W. CUMLEY. 1958-59 Series. Chicago, U.S.A.: Year Book Publishers, 1959. 7¼" x 6½", 570 pp., 202 figures. Price: 88s. (Aust.).

This is the third volume of the *Year Book of Cancer*, and the editors have maintained the high standard of previous issues. From a total of approximately 4,000 articles published in the preceding year, 298 abstracts have been prepared. There is a strong bias in favour of American publications, two-thirds of the abstracts being of American origin. It is a little disappointing that no article published in Australia or New Zealand was selected for abstraction. Russian and East European publications are also omitted.

The prepared abstracts are very informative and in most cases a concise account of essentials has been prepared. Many tables and figures are also reproduced. Most of the editorial comments made are somewhat dogmatic and often seem redundant. Perhaps these comments would be more useful if confined to noting any specific fallacies, or providing references to related publications giving confirmatory or contradictory findings.

This Year Book is confidently recommended as an invaluable source of up-to-date information for all interested in oncology.

A CATALOGUE OF THE PORTRAITS AND OTHER PAINTINGS, DRAWINGS AND SCULPTURE IN THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

By WILLIAM LE FANU. Edinburgh and London: E. and S. Livingstone Ltd., 1960. 9¾" x 7½", xii plus 119 pp., 145 illustrations. Price: 30s. (stg.).

Of the many historical treasures housed in the Royal College of Surgeons of England, their notable collection of portraits, sculpture and other drawings gives greatest pleasure and adds beauty to their noble building in Lincoln's Inn Fields. The history of surgery and anatomy has always been fostered at the College and this is shown on every side in their great Museum collections. It was a matter of great good fortune associated with foresight that their portrait collections were dispersed to the country in the early stages of the last war and thus escaped destruction in the disastrous bombing of 10th May, 1941, when so much of the Museum was lost for ever.

A catalogue of their art collection had been compiled by Sir Frederic Hallett in 1892, which was revised and enlarged in 1930 but both have long been out of print and out of date. Now William LeFanu, the College Librarian, has produced a magnificent catalogue with full descriptions of the 359 items listed and illustrations of almost half of them. This catalogue, written in a most scholarly fashion, does great credit to the College. That it should be so lavishly illustrated is due to the generosity of McNeill Love, F.R.C.S.

The catalogue is divided into two portions of which the first deals with the portraits and the second with the paintings, drawings and sculpture. As a good catalogue should be, it is very adequately indexed. Many of the drawings and paintings were originally owned by John Hunter and came to the College with his Museum. When one looks around the many portraits, both in oil and marble, that are in the College, as well as the many historical paintings, it is possible to survey the history of British surgery.

All students of the history of medicine and surgery will be grateful to the compiler for the many hours of hard work that have gone into this catalogue. That it was a labour of love is quite obvious.

CORRECTION.

In a review of J. Crawford Adam's *Outline of Fractures including Joint Injuries* which appeared in the November, 1959, issue of the *Journal*, the price was quoted as 70s. (stg.). This should have been 27s. 6d. (stg.). The error is regretted.

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